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EIGHTEENTH ANNUAL REPORT  
of  
Pasture Research  
in the  
Northeastern United States  
State College, Pennsylvania  
1954

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1954  
Eighteenth Annual Report  
of  
Pasture Research  
in the  
Northeastern United States

U. S. Regional Pasture Research Laboratory  
State College, Pennsylvania  
Forage Crops and Diseases Section  
Field Crops Research Branch  
and  
Eastern Section of Soil and Water Management  
Soil and Water Conservation Research Branch  
Agriculture Research Service  
of the  
U. S. Department of Agriculture  
and  
The Agricultural Experiment Stations  
of the  
Twelve Northeastern States  
Cooperating

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Copies of this report were sent to all organizations involved in the development of the present pasture research program in the twelve Northeastern States and in addition to some institutions outside the Region where grassland research is a major interest.

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## THE LABORATORY STAFF

R. J. Garber	Director
Lois L. Smith	Secretary

### Project Leaders

V. G. Sprague	Agronomy
J. T. Sullivan	Plant Chemistry
R. R. Robinson	Soils
H. L. Carnahan	Cytogenetics
J. H. Graham	Plant Pathology

### Assistant

Helen D. Hill	Cytogenetics
---------------	--------------

### Part-Time Assistants

F. L. Barnett	Cytogenetics
S. W. Braverman	Plant Pathology
G. H. Elkan	Soils
R. B. Forbes	Soils
D. G. Routley	Plant Chemistry
Anna K. Storgaard	Cytogenetics

## COLLABORATORS

B. A. Brown, Connecticut	M. A. Sprague, New Jersey
C. E. Phillips, Delaware	S. S. Atwood, New York
C. S. Brown, Maine	M. A. Farrell, Pennsylvania
A. O. Kuhn, Maryland	R. C. Wakefield, Rhode Island
W. G. Colby, Massachusetts	G. M. Wood, Vermont
H. A. Keener, New Hampshire	G. G. Pohlman, West Virginia

\* \* \* \* \*

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## PASTURE RESEARCH IN THE NORTHEASTERN UNITED STATES

This progress report is intended primarily for the use of personnel engaged in forage crop research in the twelve Northeastern States and contains a summary of progress in the Region during 1954. Activities at the Pasture Laboratory, at each of the twelve state agricultural experiment stations and those sponsored by the Forage Crop Technical Committee are included. The chairman of this Committee submitted the report of the regional project, the collaborators were responsible for assembling and editing the material from their respective stations and the project leaders at the Pasture Laboratory prepared the statements describing their research.

Few personnel changes occurred during the year. Mrs. Lois L. Smith was appointed Secretary to fill the vacancy when Mrs. Vivian L. Troutman resigned. Mr. Victor M. Held completed his graduate work for the doctorate and accepted an appointment as plant pathologist at Camp Detrick. Mr. Simon Baker resigned to accept a graduate assistantship at Clarke University.

A pasture collaborators' conference was held July 27 and 28, 1954 at Cornell University with about 40 plant and animal scientists present. The primary purpose of the meeting was to encourage a regional attack on animal-plant problems of forage crops. Minutes of the meeting were distributed to participants and other interested persons in the Region. At this meeting a special committee consisting of J. T. Sullivan, J. T. Reid, and A. O. Kuhn was appointed to help crystallize thinking on forage crop problems that would seem to yield most readily to a joint approach. Some weeks later this special committee completed an eight page report which was distributed in the Region.

During the eighteen years since the Pasture Laboratory was established, the collaborators have held twelve regional meetings and sponsored eight others. These conferences together with the more recently inaugurated series by the various Technical Committees appointed by the Directors of the state agricultural experiment stations and supported by federal regional funds have been most effective in promoting cooperative regional research on forage crops. At present, the following Technical Committees are concerned wholly or predominantly with forage crops, NE-13 (Mechanization), NE-18 (Economics of forages), and NE-21 (Forages). With the growth and expansion of various aspects of forage crop research in the Region, the need for continual scrutiny to preserve coordination of effort becomes increasingly important.

## RESEARCH AT THE PASTURE LABORATORY

GENETICS AND PATHOLOGYAlfalfaInheritance of Flower Color in Medicago sativa

Progenies of crosses (1953 Annual Report, page 4) were classified for flower color in the field. Results indicate that white flower color may be conditioned by an inhibitor gene or by the absence of one or both dominant complementary genes for color. One cross of white x white which gave both white and purple flowered plants is being studied further. Purple flowered segregates from a cross presumed to be nulliplex x simplex are being selfed to ascertain to what extent tetrasomic inheritance may prevail in the present materials.

## Alfalfa Heritability

The 25 plants selected in 1953 from the NE-10 planting were selfed and cloned. A spaced planting of 5 plants of each of these clones and 10  $I_1$  plants from each was established in four replications to study genetic and environmental variances. Analyses of scores on leafhopper damage indicated highly significant differences among clones, among  $I_1$ 's and a highly significant interaction of strains x generations. The correlation between reaction of clones to leafhoppers and reaction of their  $I_1$ 's was + .56\*\*.

Comparison of Progenies of Spreading and Upright  
 $F_2$  Alfalfa Selections

This planting (1953 Annual Report, page 3) was harvested in 1954 - 3 cuttings from plots managed for hay and 4 cuttings from plots to simulate grazing. No reduction of stand had occurred by the end of the season but some plants in the "pasture" plots appeared weakened.



Analysis of the yield data indicated significance as follows:

	<u>Alfalfa fraction</u>	<u>Alfalfa + associated S-37 Orchardgrass</u>
Strains	* *	* *
Mgts. (Hay vs. Pasture)	* *	* *
Strains x Mgt.	* *	*
Cuts (1st vs. total of aftermath)	* *	* *
Cuts x Strains	* *	* *
Cuts x Mgt.	* *	* *
C x S x M	*	---

In this test the checks, Rhizoma and Narragansett, were highest in yield, producing nearly 50% more than Buffalo. The upright progenies on the average yielded 5% more than spreading progenies, but there was considerable variation in both groups. Though spreading types exhibited broad crowns there was no evidence of spreading.

The cuts x strains interaction largely reflects the more pronounced superiority of Narragansett, Rhizoma, and high yielding selections at the aftermath harvests than at the first harvest. Alfalfa fractions of the yields on plots managed to simulate grazing were 34, 76, and 57% of the yield of the same strains managed for hay at the first cut, aftermath cuts, and season total, respectively. Comparable values for the alfalfa plus orchardgrass yields were 39, 89, and 66%, indicating that the orchardgrass yielded relatively more on plots where the alfalfa plants had been weakened by more frequent cutting.

#### Selection for Disease Resistance in Alfalfa

Over a period of four years, selections and crosses have been made of strains of alfalfa for resistance to Pseudopeziza medicaginis and Ascochyta imperfecta, the causal agents of common leafspot and black stem, respectively. During the past year, disease notes were taken on F<sub>1</sub>, F<sub>2</sub>, S<sub>1</sub>, and S<sub>2</sub> plants in field plots. Twenty-six plants which appeared to be homozygous for resistance to P. medicaginis, A. imperfecta, and an eyespot - causing pathogen (probably Pseudoplea sp.) were brought into the greenhouse and are being backcrossed to Vernal and some of the better selections made at the Laboratory. The resistant clones used in the above studies are available to plant breeders in the region.

## Ladino Clover

### Self-compatible Ladino Clover

Further selfing of apparently exceptional plants in self-compatible and self-incompatible  $I_1$  families has indicated that the present material has degrees of self-compatibility. Average number of self seeds per 10 florets on 8 most self-compatible  $I_1$  clones was 22.0; on 6  $I_1$  clones intermediate in self-compatibility, 4.2; and on 12 self-incompatible clones, 0.4. Reciprocal crosses among plants of the three classes have been made. Self-compatible plants have also been crossed with clones exhibiting red flecking on the leaves and others with red leaves.  $F_1$  plants will be selfed.

In pollen mother cell smears from self-compatible and self-incompatible clones quadrivalents have been observed. It remains to be determined whether these are due to translocation heterozygotes or are owing to some homology between chromosomes of the two genomes. Inbred populations segregating for albinism may provide some evidence on possible tetrasomic inheritance.

### Inheritance of Leaf Markings in Ladino Clover

Data collected over a period of years have been summarized and a paper has been submitted for publication on the inheritance of leaf mark patterns and anthocyanin characters. The V-markings are inherited as a series of multiple alleles. In certain selfed populations slightly aberrant ratios were obtained. It is possible that there is loose linkage between the V-locus and the S-locus. Evidence was also obtained that red flecking and red leaves are conditioned by alleles.

### Recombination of Characters in Trifolium repens

Four of the 9 selections were crosses in all possible combinations to produce 6 single crosses. The six  $F_1$  populations were grown in the field and 4 plants selected in each. The  $F_1$  selections within each group will be intercrossed to produce  $F_2$  seed.  $F_1$  and  $F_2$  populations will be compared in an effort to ascertain the reduction in vigor in  $F_2$  of 2-clone synthetics and to obtain additional selections combining the desired characteristics.



### Selection for Persistence at Low Light Intensity

Seven clones have been selected as parents of a synthetic. These clones flower approximately three weeks earlier than ordinary Ladino clover and are intermediate in size. Single crosses among these clones will be used as material for recurrent selection.

### Selection for Resistance to Sclerotinia trifoliorum

The 90 clones selected last year (1953 Annual Report, page 5) were observed in a polycross nursery and seed was harvested. On the basis of such notes as winter injury, leaf diseases, spring and summer recovery, vigor, and density, seven clones have been selected for a synthetic. An attempt will be made to produce seed of these in a cage in 1955. Single crosses among these 7 clones are being made for another cycle of selection. Polycross progenies of some of the selections among the 90 clones will be established. The project on the chemical control of S. trifoliorum has been discontinued. In the 1953 test (1953 Annual Report, page 11) insufficient disease developed to evaluate the chemical.

### Red Clover

#### Root Rot Complex of Red Clover

Sixteen clones of red clover selected in 1953 (1953 Annual Report, page 11) were crossed in all combinations during the winter of 1953-1954. Five of these clones traced to Rahn, three to Pennscott, and one each to Reinholdt, Dollard, Wegener, Purdue, W.M.R., Wisconsin polycross, Essi, and a Denmark clone. The  $F_1$  seeds were planted in flats and the seedlings with the original clones transplanted to the field last spring. Notes are being taken on flowering, vigor, and disease incidence. All plants will be dug in fall 1955 and the roots rated for disease and root borer damage.

### Inoculation Techniques with Sclerotinia trifoliorum

A series of field tests is underway to determine the best time of the year for inoculation of red clover with S. trifoliorum for selecting for resistance (1953 Annual Report, page 11). One year's data indicate that plants should be inoculated between October 1 and November 1 to obtain the maximum amount of infection.

### Physiology of Sclerotinia trifoliorum

One phase of the physiological studies of S. trifoliorum has been completed and submitted for publication. In comparing a normal strain (pathogenic) and a degenerate variant (non-pathogenic) (1953 Annual Report, page 11) minor differences were noted between the strains in capacity to utilize organic and inorganic sources of nitrogen and in responses to certain B vitamins. The degenerate strain produced more protopectinase than the normal, indicating that either some other enzyme is active in the infection process or that some other phenomenon is involved. It was demonstrated that the normal strain secretes a thermostable, toxic substance which causes excised Ladino clover leaves to wilt under conditions inducing rapid transpiration. Filtrates of the degenerate strain did not cause wilting.

Tests are now underway to determine the nature of the toxic substance and to learn whether it can be used as a rapid method of testing clones for resistance to S. trifoliorum.

### Meadow Fescue and Perennial Ryegrass

#### Intergeneric Hybridization

A paper describing the meiotic behavior of triploid hybrids and colchicine techniques for producing the autoallohexaploids has been prepared for publication. There were significant differences among triploids in the number of univalents at metaphase I. Per cent of apparently good pollen varied from 0 to 3.2% among triploids. Tri-valent associations were fairly common and were interpreted as indicating some homology between perennial ryegrass and meadow fescue chromosomes.

Triploid and hexaploid clones have been supplied to Dr. Sparrow for a study of the possible relationship between chromosome number and lethal irradiation dose. Plans are also being made to irradiate the triploids in an attempt to induce fertility--either apomictic or sexual.

Attempts will be made to cross the hexaploid derivatives with tall meadow fescue in an effort to combine palatability, productivity and wide adaptation.

More than 1000 open pollination progenies of triploid  $F_1$ 's will be observed for fertility and desirable combinations of characters. The seed was produced on plants growing near the two parents.



## Helminthosporia on Intergeneric Hybrids and other Forage Grasses

In observations of the above perennial ryegrass-meadow fescue hybrids, leaf lesions caused by a species of *Helminthosporium* were found on some plants. Diseased leaves showed irregular brown blotches consisting of short, indistinct horizontal and longitudinal streaks, or more often a solid brown band extending across the blade and up to one inch long. Conidia and conidiophores from the hybrid were compared with those from diseased leaves of adjacent meadow fescue and perennial ryegrass plants and with known isolates of *H. dictyoides* (from *Festuca* sp.) and *H. siccans* (from *Lolium* sp.). The pathogens from adjacent plants of meadow fescue, perennial ryegrass, and the hybrid were similar morphologically to the known isolate of *H. dictyoides*. The results of cross inoculation studies are given in the following table:

Table 1--Symptoms produced by *Helminthosporia* on meadow fescue, perennial ryegrass, and a hybrid between them.

<u>Inoculum</u>	<u>Plants</u>		
	<u>MF</u>	<u>PM</u>	<u>PR</u>
<u>H. dictyoides</u>	Net	Trace	0
H. from MF	Net	Trace	0
H. from PM	Trace	Blotch	Blight
H. from PR	0	Blotch	Blight
<u>H. siccans</u>	Spot	Spot	Spot

The above data indicate that the *Helminthosporium* on ryegrass and the hybrid is a new form of *H. dictyoides*.

A foliar disease of timothy, found in Pennsylvania in 1950 and more recently in other Northeastern States, was studied and the causal agent identified as *Helminthosporium dictyoides* var. *phlei*. Symptoms consist of irregular, light-brown, necrotic streaks with conspicuous chlorotic borders. The fungus is differentiated from *H. dictyoides* in spore morphology, production of secondary conidia, and host reaction. In cross inoculation studies involving the common forage grasses, the *Helminthosporium* from timothy attacked only that host. *Helminthosporium dictyoides* and related species did not infect timothy. The optimum temperature for mycelial growth was between 24° and 28°C., for infection and disease development, 20° and 24°C., and for sporulation on host tissue, 15°-24°C.

Another *Helminthosporium* has been isolated from orchardgrass. The sexual stage was also found and identified as *Pleospora* (*Pyrenophora*) *phaeomes*. Formerly, it has been reported on *Holcus* sp. and *Calamagrostis* sp. The asexual state apparently has not been previously described. Although the economic importance of the disease has not been evaluated in artificial inoculations, orchardgrass plants were severely damaged while meadow fescue,

8.

perennial ryegrass, and tall oatgrass were not infected.

Physiological studies are underway on the above and related species of Helminthosporium attacking forage grasses.

#### Crown Rust Immunity in Diploid Festuca elatior

Four immune clones were established in a polycross nursery for seed production. Seed harvested from this nursery will be available in limited quantity to anyone interested in the species.

#### Bromegrass

##### Selection for Increased Seedling Vigor in Bromus inermis

Polycross seed of selections (1953 Annual Report, page 7) was harvested and polycrosses are being evaluated in greenhouse plantings at a depth of 1-3/4". Significant differences have been obtained among polycrosses in rate and number of seedlings emerged. Polycrosses of most selections gave emergence superior to Lyon and New York synthetic "B". Selections are being made from most vigorous progenies. Greenhouse results will be compared with germination vigor and field emergence. Weight of seed has been obtained and polycross seed of some clones is twice as heavy as that of others.

##### Interspecific Hybridization in Bromus

Data from the karyological investigations of 1953 were prepared for publication. A study of the meiotic behavior of 11 triploid hybrids between diploid and tetraploid species of the Bromopsis section was begun. Preliminary results indicated considerable chromosome pairing in metaphase I cells of these hybrids. In all plants examined there appeared to be an approximation of the  $7_{II} + 7_I$  scheme of pairing, although occasional cells exhibited trivalents. All hybrids showed high frequencies of anaphase I laggards and quartet micronuclei.

A study involving colchicine treatment of the 11 triploid hybrids was initiated to: 1. provide hybrid materials having doubled chromosome complements, and 2. investigate the influence of duration of treatment upon the effectiveness of colchicine in producing doubled material.



Tillers from each hybrid were treated with a 0.25% aqueous solution of colchicine for periods of 11, 22, 33 and 44 hours. They were then allowed to grow into plants which are being examined for doubled material. Results to date indicate very little chromosome doubling following the 33- and 44-hour treatment. There is also some indication of interhybrid differences in the amount of chromosome doubling with any given treatment.

#### Correlation of Characters in Bromus inermis

Some correlations between characters on 118 clones are: date anthesis vs. seed weight  $-.27^{**}$ ; leaf width vs. seed weight  $+.45^{**}$ ; leaf width vs. susceptibility to P. bromi  $-.26^{**}$ ; leaf width vs. susceptibility to Rhynchosporium  $-.09$ ; per cent sterile florets vs. seed yield  $-.45^{**}$ . An analysis of data on per cent sterile florets indicated that clones could be characterized better by sampling one head from several plants than two heads from fewer plants.

#### Hexaploid Bromus inermis

Shriveled seeds harvested from a clone of B. inermis ( $2n = 28$ ) which was surrounded by normal octaploid brome grass ( $2n = 56$ ) were planted. Chromosome counts indicate that seedlings have either 28 or 42 chromosomes. Meiosis of the hexaploids will be studied and a hexaploid synthetic established.

#### Reaction of Bromus to Pyrenophora bromi

Results of a study of reaction of Bromus spp. to this organism were published in the Plant Disease Reporter. A self-sterile clone of B. sibiricus ( $2n = 28$ ) with some resistance has been interplanted in a B. inermis polycross nursery in hopes of obtaining interspecific hybrids.

Thirty-six clones of B. inermis (25 most resistant, 6 intermediate, and 5 most susceptible) were selected from a group of 115 clones in the field. Reaction of the clones in the greenhouse will be compared with field reaction; and polycross and  $I_1$  reaction in the greenhouse will be compared with greenhouse and field reaction of the parent clones. At the same time, there will be further selection for resistance.

Orchardgrass

## Selection for Resistance to Foliar Diseases

In a clonal planting of selections, some of which were included in the NE-21 test, a severe epiphytotic of leaf rust occurred. Ten clones in this planting were vigorous and highly resistant to rust. Emphasis on selection for disease resistance will be concentrated on progenies of these clones.

Dactylis aschersoniana x D. woronowii

In general this material (1953 Annual Report, page 9) is much less vigorous than orchardgrass (D. glomerata). There is wide segregation for maturity, the backcrosses to the respective parents approaching the recurrent parent in time of flowering and other characters.

Reed CanarygrassProgenies of 35-Chromosome Phalaris arundinacea

Open-pollinated seed was harvested from 42- and 56-chromosome plants growing in the aneuploid nursery. Seed set was better on 42- than on 56-chromosome plants. Some of this seed has been sent to forage workers in Oklahoma, Kansas and California.

An octaploid and a hexaploid isolation have been established for seed production. Collections have also been made for continued cytological study.



## BIOCHEMISTRY, PHYSIOLOGY AND SOILS

## The Chemical Composition of the Pasture Grasses

(In cooperation with T. G. Phillips  
of the New Hampshire Station)

Studies have been completed on grasses growing in small plots. Most of the data have been published in previous reports (1953 Annual Report, page 13). Correlations have been calculated among constituents of eight grasses grown two years and harvested successively at grazing heights. For both seasons, highly significant positive correlations were obtained between any two among the group of protein, soluble ash, and ether extract, and also between any two among the group of lignin, cellulose, and crude fiber. Negative correlations, most of them significant, were obtained between any two constituents if one belonged to the former group and the other to the latter group.

Measurement of the Nutritive Value  
of Pasture Plants

Studies were continued on samples of grass which had been fed to sheep at the Pennsylvania Station and on the feces of the same animals (1952 Annual Report, page 12). The objective in this work is to collect information which will be useful in predicting the nutritive value of forages from chemical analysis alone.

In first-cut grasses harvested at the same stage of growth, true cellulose amounted to 25-35 per cent with digestion coefficients of 63-85. The percentages were of the same order as those of crude fiber, but the digestion coefficients were higher. Natural cellulose exceeded true cellulose by 7-11 per cent and its digestion coefficients were slightly, but without exception, lower than those of true cellulose. Lignin ranged from 4.7-8.8 per cent and its digestion coefficient from 3-12. Successive cuttings of orchardgrass during the growing season had a range of 22-29 per cent true cellulose, 74-89 in digestion, and 4.5-7.6 per cent in lignin. There was a general tendency for the digestibility of the cellulose to decrease as the season advanced. The cellulose and lignin contents of timothy hay increased with the stage of maturity and their digestion coefficients decreased.

Sugars obtained from the acid-hydrolyzable carbohydrates and derived chiefly from hemicelluloses were in the main nonfermentable and probably pentoses. They indicate that hemicelluloses amounted to 15-18 per cent and had digestion coefficients 52-79. The total alcohol soluble matter amounted to 17-31 per cent, and the total dry matter extracted by acid following the alcohol to 30-38 per cent.

The following relationships will be useful in evaluating forage grasses. Lignin percentages were correlated negatively with the digestion coefficients of both celluloses, hemicellulose and total dry matter,  $r$  exceeding 0.90 in each case. Total alcohol-soluble substances were positively correlated with digestible dry matter, the coefficient being 0.90. Both soluble substances, which have a high digestibility, and lignin with a low digestibility should be considered in any improved scheme of analysis of grasses.

#### Comparative Protein Content of Reed Canarygrass and Timothy Clones

The crude protein of orchardgrass clones was related to the date of emergence from the boot and the date of flowering, the early clones being higher in protein than the later clones at a comparable stage of growth. Correlation coefficients between protein content and either the date of emergence from the boot or the date of flowering were negative and highly significant (1953 Annual Report, page 14). Further study of the data disclosed that the correlation coefficient between leafiness and date of field bloom was significant at the 1 per cent point ( $r = 0.43$ ); that between leafiness and protein was not significant.

Two other species were studied in 1954. A total of 107 reed canarygrass plants were selected at random from a polycross nursery and harvested when 8-12 heads were visible per plant, just emerging. The dates of harvest ranged from May 24 to June 11 with a maximum of 6 plants selected on any one day. Protein ranged from 8.1-16.5 per cent, an average of 12.1. The correlation between protein and date of heading was not significant. Apparently no relation exists between date of maturity and protein content in reed canarygrass.

Of the several thousand plants in the nursery only 8 were found which contained no, or at most 2, heads per plant, and they were sampled on June 16. Protein ranged from 8.8-13.6 per cent with an average of 11.5. The protein content of these non-heading plants was of the same order as in those which headed.

Twelve early timothy plants were harvested at the half-emerged stage, June 1-2, 1954. They contained 8.9-12.3 per cent protein, with an average of  $10.47 \pm 1.02$ . Twelve late plants at the same stage on June 14 contained 7.3-12.4 per cent, an average of  $8.76 \pm 1.72$ . The average difference between the early and late groups was not significant.



### Nutrition of Ladino Clover

The persistence of Ladino clover in a sod may depend in part on favorable conditions for the growth of new seedlings. The effect of organic compounds, especially those containing nitrogen, was determined on very young seedlings newly transplanted from the germinating chamber into test tubes containing a complete nutrient solution. Plants grown at five concentrations of each compound, 5, 50, 200, 500, and 1000 p.p.m., were studied and the results measured by the weight of the plants after 30 days.

Compounds which were not toxic to the growth of the seedlings except at high concentrations were amino acids, some organic acids, and some nucleic acid decomposition products. The alkaloids were more toxic. The most toxic substances of all were caffeine, xanthine, hydroquinone, stovaine, benzidine, quinoline, sulfapyridine, and some antibiotics. Pencillin, however, was toxic only at 1000 p.p.m. Toxicity of some compounds at high concentration may be due to increased osmotic pressure of the nutrient. The toxicity of high concentrations of organic acids was not due to the pH.

Nitrogenous compounds were also tested as to their ability to serve as sources of nitrogen in nutrient solutions lacking inorganic nitrogen. Good nitrogen sources were found to be methylamine, succinimide, the amino acids (except L-cysteine, DL-methionine, and DL-norleucine), nucleic acid decomposition products (except xanthine), the vitamins p-aminobenzoic acid, niacinamide, and calcium panthothenate, and of the alkaloids only trigonelline.

A report entitled "Toxic and nutritional effects of various compounds on Ladino clover seedlings" was presented as a master's thesis to The Pennsylvania State University.

### Cutting Practices as They Affect the Persistence of the Stand of Alfalfa and Its Carbohydrate Reserves

Alfalfa plots used in this study have satisfactorily survived 3 years when the first crop in the spring was cut at the prebud stage of growth and the last cut in the fall was taken in late October (1953 Annual Report, page 16). Chemical analyses of root samples will be made during the next year.

A second series of alfalfa plots including certified Ranger and Vernal varieties was established and subjected to similar early spring cutting treatments during 1954. Dry matter yields indicated almost no differences in the season totals irrespective of the times when the first cuttings were taken in the spring. The seasonal yield, however, was more evenly distributed and included one more harvesting period during the summer when fresh forage is often at a premium.



### Moisture Content of the Air in the Microclimate Above a Grass Sod

The amount of moisture in air and temperature of the air at heights of 1-1/2 inches, 3 inches, 6 inches and 5 feet, above a Kentucky bluegrass sod have been determined from April through October 1952-1954 inclusive. The readings were obtained at 2-hour intervals during the day from 6 a.m. to 6 p.m., and during the night at 3-hour intervals.

Monthly averages of these data indicate that while there was variation between months, the amount of water in the air was generally greatest near the ground surface and decreased with increasing height above it. The fluctuation of the moisture content of the air during each day varied with proximity to the grass sod surface. For example, the average dew-point for July of air at the 1-1/2-inch height ranged from 57-71-1/2°F.; at the 6-inch height it ranged from 57-64°; at the 5-foot height it ranged from 59-61°F. The greatest amount of water in the air existed at time of the daily maximum air temperatures and the least amount of water at the daily minimum temperatures. During May the dewpoints at the minimum daily temperatures were almost the same at the different heights while during April and the three summer months, the dewpoints near ground level at the times of minimum temperatures were slightly lower than the dewpoint at the 5-foot height.

Air temperature measurements were taken at the same time that the dewpoints were determined. From these data, relative humidities were calculated for the various heights.

Air temperatures at different heights followed a pattern similar to that previously reported, i.e., at locations nearest the surface of the sod daily maximum temperatures were highest and daily minimum temperatures lowest. This pattern occurred during each of the months from April through October during the 3-year period.

When the moisture content of the air is expressed as the relative humidity, it is evident that lower daily averages of relative humidities occurred at the 5-foot height and that higher average humidities occurred at the 1-1/2-inch height and at both the maximum and minimum air temperature.

A comparison of relative humidities at the time of daily maximum temperatures in different months indicated that during the daytime May was most humid and July was least humid. At the time of the minimum temperatures, August and September were most humid and particularly near ground level where the relative humidity averaged 96% for each of these months.

Conditions of 100% relative humidity occurred much more frequently near ground level than at increasing heights above it. The frequency and duration of these conditions near ground level are undoubtedly important factors in determining the severity of disease and insect pests of forage crops.



### Plant Climate: Soil Temperatures Under a Kentucky Bluegrass Sod

In conjunction with climatic conditions above ground, the daily maximum and minimum temperatures were determined at various depths below the soil surface. The depths at which temperatures were determined were 1 inch, 2, 4, 8, and 16 inches beneath a Kentucky bluegrass sod that was clipped to maintain a grass-cover at heights from 1-1/2 to 2 inches. To measure the temperatures copper-constantan thermocouples were used with a recording potentiometer. Readings were obtained on the even hours from 6 a.m. to 6 p.m., and at 3-hour intervals during the night. The mean daily temperature ranges are much greater near the soil surface and these decrease rapidly with increasing depth. It is also evident that these ranges were greatest during midsummer when air temperatures near the soil surface were highest.

Extreme maximum and minimum temperatures for the various months follow the same general pattern with increasing depths as do the mean maximum and mean minimum temperatures.

Data recorded for diurnal changes of soil temperatures indicate that maximum temperatures at the 1-inch depth occur at about noon. This is about the same time that maximum air temperatures occur at a 3-inch height above the ground. At the 2-inch depth, the maximum temperature occurs at 2 p.m., at 4 inches between 2 and 4 p.m., at 8 inches at 6 p.m., and at 16 inches deep the temperature is highest at about midnight.

The minimum soil temperatures near the surface follow a diurnal sequence similar to that observed for air 3 inches above ground level. At greater depths greater lags occur; the minimum temperature at the 16-inch depth occurs between 10 a.m. and noon.

Monthly averages of daily means during the period from May to November indicate considerable differences in temperature with depth during the summer months and in a reverse direction and to a lesser extent during the fall and winter months.

### Legume Seedling Establishment

The total germination of Ladino clover seed and its rate of germination were studied on blotters in Petri dishes at eight 5-degree temperature intervals from 5°C-40°C. The effect on germination of a daily alternation of temperatures within this range was also studied. At constant temperatures, germination was most rapid at 20°C., with only slight decreases at 15° and 25°C. Within 5 days after the seeds were moistened, germination was almost complete at 20°C. When alternating temperatures of 10° at night and 20° during the day were used, one-half of the seed germinated within two days, and germination was almost complete in three days.



Germination under cooler temperatures ( $5^{\circ}\text{C}.$  and  $10^{\circ}\text{C}.$ ), both constant and alternating, resulted in the highest total per cent germination. This probably was due to the hard seeds that gradually changed and took up water and then germinated. This was most apparent under conditions of alternating temperatures of  $5^{\circ}$ - $10^{\circ}$ ,  $5^{\circ}$ - $15^{\circ}$ , and  $5^{\circ}$ - $20^{\circ}\text{C}.$  although it also occurred at a constant temperature of  $5^{\circ}\text{C}.$

Higher constant temperatures of  $30^{\circ}$ ,  $35^{\circ}$ , and  $40^{\circ}$  reduced the rate of germination and progressively decreased the total germination. Alternating night temperatures of  $10^{\circ}$ ,  $15^{\circ}$ , or  $20^{\circ}\text{C}.$ , however, with the higher daytime temperatures resulted in more rapid and also higher total germination.

### The Role of Hard Seed of Ladino Clover in Natural Reseeding

Natural reseeding of Ladino clover appears to offer one means of helping to maintain stands. Instances have been noted where natural reseeding gave good stands following loss of the original plants. Most of the mature seeds of Ladino clover are impermeable. It seemed desirable, therefore, to determine how long the seed remains impermeable under natural reseeding, both when the seed remains at or near the soil surface and when it is plowed under.

Three approaches to the problem are being investigated as follows:

1. a known number of hard seeds was seeded in a small area and records kept of dates of seedling emergence;
2. hard seed was wrapped with soil in fiber glass cloth and placed at different depths in the soil as well as on the surface of the soil. The numbers of hard seeds remaining are being determined over a period of years; and
3. Laboratory studies are being conducted to determine the effect of temperature, moisture, oxygen, and carbon dioxide on germination.

The results to date suggest that the persistence of hard seeds over long periods of time when buried in the soil is associated with favorable temperature relations rather than oxygen or carbon dioxide concentrations. Temperature relations at or near the soil surface are such that most hard seeds become permeable over winter. At deeper depth, such as in seeds that are plowed under, the changes in temperature are not sufficiently rapid to induce a high percentage of germination and the seeds remain hard for a much longer period. Thus after 12 months 80% of the hard seed buried at 6 inches was recovered as compared with only 10% for seed at the soil surface or  $1/4$  inch deep.

Hard seed on moist filter paper gave 60% germination in 2 months when the seed was shifted daily from 1° to room temperature (shifting from 1°-20° gave similar results), as compared with no germination at room temperature and 3% germination at 1°C. Daily shifts in temperature, however, were not necessary. Germination at the end of 2 or 3 months was as high in seeds kept at 1°C. and shifted to room temperature only 1 day per week as in seed shifted daily. Moreover germination at the end of 2 months was as high in hard seed kept at 1°C. for 7 weeks and then shifted daily from 1°C. to room temperature as in samples that were subjected to daily alternations in temperature for the entire 2 months.

The striking response to alternating temperatures following prolonged exposure to low temperatures is illustrated with one lot of hard seed that gave no germination during 6 weeks at 1°C. The seed was then moved to room temperature for only 5 hours and returned to the 1° room. Within a week 20% of the seed became permeable. The effect of the single day at room temperature, however, did not extend beyond a period of about a week.

On the other hand, shifting seed from 1°C. to room temperature weekly (i.e. alternating 1 week at low temperature with 1 week at room temperature) is relatively ineffective in breaking the seed coat.

These data indicate that the persistence of seed of Ladino clover, and probably certain other legumes, for years when buried in the soil can be attributed to the slow changes in soil temperature. Seeds near the soil surface on the other hand are subjected to a long period at low temperatures during the winter and when spring comes all that is needed to break the seed coat is a few warm days followed by cool nights.

#### Responses of Grasses vs Legumes to Phosphorus and Potassium Fertilization

Results the second harvest year continue to show much greater response to phosphorus fertilization by alfalfa than by nitrogen fertilized orchardgrass (1953 Annual Report, page 17). However, again the responses to potassium are small and appear to be no greater in alfalfa than in orchardgrass. This poor response to potash fertilization, particularly by alfalfa, is of interest because the soil tested low in potash at the start of the trial and marked responses to potassium were obtained in the young seedlings of both alfalfa and orchardgrass. Soil and plant analyses have not been completed.



### Fertilizer Placement for Perennial Forage Crops

Seedlings of perennial grasses and legumes were made in the spring on soils of low fertility and moderately high fertility levels. In one series phosphate was applied at various rates both in bands and mixed with the soil. In this series potash was applied uniformly to all plots. In another series, uniformly fertilized with phosphate, potash was applied in bands vs mixed with the soil. In still another series, the phosphate and potash were applied together, both in bands and mixed with the soil. Seedlings were also made at several dates in the fall to determine the effect of placement and rate of fertilization on seedling survival during the winter.

The results to date indicate relatively little advantage from band placement of phosphate and no advantage from band placement of potash, even at the lowest rate of application. Higher rates of potash (80 pounds  $K_2O$  per acre) in the band appeared to decrease stands and rate of growth of the seedlings.

### Frequency of Irrigation

The experiments in glazed sewer tile to determine the effect of frequency of irrigation for different soil conditions and different plant species were continued (1953 Annual Report, pages 18-19). In this investigation, high rates of fertilizer were used in an attempt to supply adequate nutrients for optimum plant growth. Portable covers were used to protect the tile from rainfall during June, July, August, and early September so that the soil could be dried to desired levels before irrigation.

Five levels of irrigation were used. Those maintained at the highest soil moisture were irrigated when resistance readings on gypsum block at a depth of 4 inches reached 3000 ohms. At the lowest moisture level, water was withheld until the soil approached the wilting point to a depth of 24 inches.

The data were calculated on the basis of 100 for the relative yield of each species under the most frequent irrigation treatment. For alfalfa, relative yields under the least frequent irrigation were 122 for the first cutting and 77 for the period from early June to early September, with an average of 90 for the season. Since all plots receive natural rainfall from late fall until the first of June, it is apparent that differences in yield in the spring of the year can be attributed to the effects of irrigation applied during the previous year. Thus it appears that frequent irrigation of alfalfa in 1953 decreased the yield in the spring of 1954. Additional evidence of this carry-over effect



was obtained in the plots that receive only natural rainfall during the entire year. On this series, following a dry summer in 1953, relative yields were 143 for the first cutting in 1954 and 74 for the remainder of the summer when moisture was somewhat below normal. The relative yield for the entire season was 94.

In orchardgrass, again using values of 100 for the yield under most frequent irrigation, the yields under the least frequent irrigation were 108 in the spring and 68 during the summer with an average of 82 for the season. For the series receiving natural rainfall, which for this year was somewhat below normal, the corresponding values were 114, 76, and 90. Thus the data for orchardgrass agree with those for alfalfa in that frequent irrigation during midsummer increased production during that period but decreased yields the following spring.

In an additional treatment this year no water was applied between June 4 and August 4. Before the end of this period, soil moisture was below the wilting point to a depth of more than 24 inches and growth appeared to have stopped. On August 4 all plots were clipped and those previously subjected to extreme drought were watered the same as those receiving the highest level of irrigation. Both the alfalfa and orchardgrass recovered immediately and in the next cutting the yields were as high as on soil that had been irrigated frequently all summer. Thus it appears that both alfalfa and orchardgrass recovered completely from severe drought immediately following irrigation.

Root distribution, based on the pattern of water removal at different soil depths, was much more extensive throughout the subsoil this year (the second harvest year) than last year. Thus the marked effect noted last year of lime and fertilizer in the subsoil on root development of alfalfa was much less apparent this year.

#### Response of Various Perennial Forage Crops to Irrigation

Field experiments were started on a Hagerstown silt loam to determine total yield and seasonal distribution of yield of 7 perennial grasses and 3 perennial legumes, both with and without supplemental irrigation. In all cases, liberal amounts of fertilizer are being applied in an attempt to provide adequate fertilizer for near maximum growth. Plots were seeded in the late summer of 1953 and yield data recorded in 1954. The irrigated series received water to bring the soil to field capacity when gypsum block readings reached 3000 ohms at the 4-inch depth.

Rainfall during 1954 was below normal during most of the growing season and on a few plots soil moisture reached the wilting point to a depth of more than 30 inches.

In most species irrigation gave increases in yields ranging from 1500-2500 pounds per acre of dry matter. In alfalfa, however, no significant increase in yield was obtained from irrigation. These preliminary results suggest the need for further consideration of the possibilities of adapted plant species for grazing during the dry periods that often occur in midsummer.

#### ORCHARDGRASS BREEDING AT BELTSVILLE, MARYLAND

Title: ORCHARDGRASS BREEDING (1952 Annual Report, pages 21-22)

Leader: A. A. Hanson

Beltsville orchardgrass was named Potomac and released in the fall of 1954 in cooperation with interested State Experiment Stations in the northeast, southeast and north central regions. The increase of this variety should aid in maintaining an authentic source of orchardgrass seed that is well adapted in the central and southern portions of the orchardgrass belt. Potomac will be recommended on the basis of (a) above average resistance to rust, (b) superior persistence, (c) superior yield performance in old stands, (d) average to superior compatibility with Ladino clover and (e) superior quality in the presence of severe rust.

Several southern orchardgrass strains were screened in a space planted nursery. These introductions were low in vigor and showed little promise at this latitude. There was a heavy epidemic of rust at Beltsville in 1954. In a replicated clonal nursery five late maturing orchardgrass clones appeared to be highly resistant to rust.  $I_1$  progenies will be grown in 1955 to evaluate the rust resistance of these selections. One hundred selections made within a group of Potomac plants grown from seed treated with thermal neutrons, were brought into the greenhouse in the fall of 1954 for selfing.



## REPORT OF COOPERATIVE RESEARCH

Title: PROJECT NE-21 - ESTABLISHMENT, PERSISTENCE, PRODUCTIVITY, AND FEEDING VALUE OF PERENNIAL FORAGE SPECIES IN THE NORTHEAST. PHASE I. SEEDLING ESTABLISHMENT AND EARLY DEVELOPMENT OF FORAGE GRASSES AND LEGUMES. PHASE II. PERSISTENCE, PRODUCTIVITY, AND FEEDING VALUE OF PERENNIAL FORAGE CROPS AS INFLUENCED BY MANAGEMENT. PHASE III. ESTABLISHMENT, PERSISTENCE AND PRODUCTIVITY OF REGIONALLY DEVELOPED STRAINS OF PERENNIAL FORAGE CROPS.

Leader: G. H. Ahlgren, Chairman, Regional Technical Committee

Cooperators: Connecticut, Delaware, Maine, Massachusetts, Maryland, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, West Virginia Agricultural Experiment Stations and The Pasture Research Laboratory.

The regional project was initiated July 1, 1954. Phase I has three objectives, namely to determine: (1) the effect of various clipping practices on establishment, early development and winter survival of forage grasses and legumes when seeded with and without a companion crop, (2) the effect of various methods of seeding and of fertilizer application on the establishment and development of forage crop seedlings, and (3) the interrelationship of species, cultural methods and climatic factors as they influence seedling establishment.

Eight experiments were started to study the effect of early management on seedling establishment and seven experiments to study the effect of various rates and placement of fertilizer and placement of seed. These studies are located in Connecticut, Maryland, New Jersey, New York, Pennsylvania, and Vermont. The Agricultural Engineering Section, U.S.D.A. cooperated in putting down the tests using specialized machinery developed by that section for uniform accurate distribution and placement of seed.

Stands for studying objective 1 were successfully established by all co-operators in April and May 1954 and eight early management and clipping treatments were applied to mixtures of alfalfa-bromegrass, birdsfoot trefoil-timothy and Ladino clover-orchardgrass grown with and without companion grain crops. Climatic data were also gathered at all stations to be used later for examining interrelationships under item 3 above. Measurements were made on speed of emergence, number of plants per unit area, weediness, height and vigor of seedlings, yield, number of tillers, and total weight of roots and tops.



In general, companion grain crops reduced the stand of weeds and initially suppressed the vigor of the seeded forages. Recovery of the forages generally followed removal of the companion grain. A single clipping of the species appeared more favorable than double clipping which seemed particularly detrimental to alfalfa and birdsfoot trefoil, suppressing development and vigor of these species.

Under objective 2, experiments were established in Connecticut, Maryland, New Jersey, New York, and Pennsylvania. Data on stand, vigor, dry weights per unit area, and crown and root development were obtained. No outstanding differences between band and broadcast seed and fertilizer placement were found except at Maryland and New York. The best treatments there were with drilled seed and banded fertilizer at high rates of phosphorus and potassium. Some advantage of drilling the seed regardless of fertilizer placement was also found.

Phase II has as objectives the following to determine: (1) forage yield, stand persistence, and feeding value of alfalfa and Ladino clover, grown alone and with grass, as affected by stage of growth at first harvest in the spring and by differential harvest of the last crop in the fall, (2) the influence of environmental factors throughout the Northeast on forage crop response to differential cutting treatments when insects are controlled, and (3) the digestibility and nutritive value of fresh and preserved forages, through actual feeding trials, as related to species and stage of growth at harvest.

For objectives 1 and 2, plots were established at the New York, Rhode Island, Maryland and the West Virginia Stations. Alfalfa, Ladino clover, brome grass and orchardgrass are the species to be investigated in detail. The seedings were made in either early spring or late summer and all stations report successful establishment of stands.

Spring and fall cutting treatments are projected since these seasons appear most critical in the management of perennial forage species. Yields and botanical and chemical analysis will form the criteria for evaluating treatments. Climatic data including maximum and minimum air temperatures, precipitation, soil temperatures and in some cases dry and wet bulk temperatures have been collected for later interpretation.

In objective 3, the New York, Pennsylvania, and New Jersey Stations are cooperating. In New York, pure seedings of alfalfa, birdsfoot trefoil, red clover, Ladino clover, orchardgrass, brome grass and timothy were established as a source of material. Pennsylvania used established alfalfa and harvested it at three stages of maturity, namely, pre-bloom, 1/10 bloom, and full bloom. Each cutting was made into silage by three treatments: (1) wilted but without a preservative, (2) unwilted with a preservative, and (3) unwilted without a preservative. Feeding trials with sheep are now underway. In New Jersey established alfalfa was harvested at pre-bloom, 1/10 bloom and full bloom and birdsfoot trefoil at full bloom, mow-dried as hay, and is ready for feeding trials with sheep.

Under Phase III are the following objectives: (1) the establishment, persistence and productivity of regionally developed strains of alfalfa, birdsfoot trefoil, smooth brome grass and orchardgrass, (2) to relate the above performance data to observable morphological and physiological characteristics of the strains, (3) to compare the performance and characteristics of strains among themselves and in relation to standard check varieties, and (4) to use this information in determining methods for the intelligent formulation of regionally adapted synthetic varieties and in establishing selection criteria for more efficient plant breeding activities.

The following experiment stations are cooperating in these tests according to crops indicated:

Alfalfa - Maine, Connecticut, Rhode Island, New York, New Jersey, Pennsylvania, West Virginia.

Birdsfoot trefoil - Vermont, New York, Pennsylvania.

Smooth brome grass - New Hampshire, New York, Pennsylvania.

Orchardgrass - New York, Pennsylvania, Maryland.

No seedlings of alfalfa were made in 1954. The Agricultural Research Service is maintaining clones and producing seed for the polycross progeny tests and seed of the experimental synthetic varieties. From seed to be produced in 1955 trials will be established in the fall of 1955 or spring of 1956.

Strains, selections, varieties, and introductions of birdsfoot trefoil, smooth brome grass, and orchardgrass have been established according to plan. Initial notes on stand and vigor have been obtained as conditions warranted.



## PASTURE RESEARCH AT STATE STATIONS

STORRS (CONNECTICUT)

Title: ALFALFA EXPERIMENTS

Leaders: B. A. Brown, R. A. Peters and E. J. Rubins

(a) Fertilization: For the third year on the same plots, the growth of alfalfa was not influenced by applying NaCl, even when used with very low amounts of KCl. Although marked increases in the Na contents of the dry matter resulted from the NaCl at low levels of KCl, none of the values were over 0.07% Na. In this experiment, the lowest content of K was 1.1%, which is very close to a starvation level.

(b) Alfalfa Varieties: In 1954, the fourth harvest season, wilt was quite prevalent in Atlantic, Common, Narragansett, Rhizome and Talent and had reduced the stands of Grimm and Variegated very seriously. Yields, especially from the second cutting, decreased as wilt increased. Certified Ranger and Buffalo had the least wilt, the best stands and high yields.

In another variety test, located on a nearby field, wilt was more prevalent in the third harvest season (1954) than in the one discussed above. Here, C130, C144, C199, C223, C183, C190, C188, C187, and C79 yielded in that order at the top of the list of thirty. None of those nine had over 5% wilt. Of the named varieties, serious amounts of wilt occurred in Atlantic, Chilean, Common, DuPuits, Narragansett, Nomad, Talent, Variegated and Williamsburg. Again, poor stands and low yields were correlated with the prevalence of wilt. Total acre yields varied from 8500 to 5500 pounds of dry matter.

Title: THE MAINTENANCE AND IMPROVEMENT OF PASTURES

Leaders: B. A. Brown and R. A. Peters

(a) The Adaptability of Varieties and Species of Grasses and Clovers for Pastures.

Ladino Clover Fertilization: In the fifth harvest season of a Ladino clover-orchardgrass seeding, the notable results were:

1. The stands of Ladino clover averaged less than 50% as thick in 1954 as in 1953. The winter of 1953-54 was a very mild one but there was much freezing and thawing of the soil because only traces of snow were on the ground practically all of the time after January 20. Under those conditions, heaving of Ladino clover was serious.
2. By far, the greatest decrease (80%) in Ladino clover occurred where very heavy amounts of  $K_2O$  (720 pounds per acre) were applied before seeding in 1949 and none since. Decreases were also relatively large under "light" liming.
3. One-half as much potash divided into annual applications produced as much dry matter in 1954 as the single large applications before seeding; also, practically the same yields were obtained from two-thirds as much potash where it was divided into four instead of one application per season.
4. Because of the reduction in Ladino clover to about 25% stands, total yields were, for the first year in this experiment, appreciably larger on the NPK than on the PK plots.
5. For the fifth consecutive season, the highest yielding raw rock phosphate treatment produced less dry matter than the lowest yielding one receiving superphosphate. The average difference was 27%. Fused tricalcium-, calcium meta- and potassium meta-phosphates have been about as effective as superphosphate.

Birdsfoot Trefoil: In 1954, a trefoil-timothy pasture, seeded in 1951, produced about the same amount of pasturage as a Ladino clover-grass pasture seeded in 1950. The average daily gains of the yearling dairy heifers on the trefoil were less in three of the four periods, the same in one.

When cut for hay, the New York broadleaf variety had a total yield of 5900 and Italian 5200 pounds per acre of dry matter. On the same field and under the same fertilization and management, twenty-three varieties of alfalfa averaged 7200 pounds.



In a four year old test of nine trefoil varieties, the total yields of dry matter from two hay cuts varied from 60 to 77 cwts. per acre in 1954. From high to low, they ranked as follows: V102, Italian, New York Broadleaf, E491, E493, E495, E501, Bunker and Empire.

Sudangrass: Compared under ten different fertilizer treatments and cut only once (September 13), Piper and Tift Sudangrass yielded practically the same, but Sweet Sudangrass produced 15% less dry matter.

Title: USE OF HERBICIDES IN FORAGE CROP MANAGEMENT

Leaders: R. A. Peters and B. A. Brown

(a) Comparison of Phenoxyacetates for Post-emergent Weed Control on New Seedlings of Alfalfa and Ladino Clover: The amine salts of 2,4-D, MCP and 3,4-dichlorphenoxyacetic acid were applied at a rate of 1/4 and 1/2 pounds acid equivalent on pure seedlings of Narragansett alfalfa and of Ladino clover on July 1, 1954. One series was seeded with Clinton oats, while another series was seeded without a companion crop. Treatments were applied when the oats were 10 inches tall and in the tillering stage. The alfalfa was 4 inches high with 3 true leaves. The Ladino clover was 4-5 inches tall with 3-4 true leaves.

Stand counts of alfalfa without a companion crop made August 10, 1954 indicated that both 2,4-D and MCP caused a highly significant decrease in stand at both the 1/4 and 1/2 pound rate. 3,4-D, however, caused no significant decrease in stand at either rate.

Ladino clover was injured much less than the alfalfa by 2,4-D and MCP. By the end of the 1954 growing season, there was an equally vigorous stand on all Ladino clover plots. A very favorable season for Ladino clover growth was probably involved.

A poor growth of oats resulted in very little protective canopy effect. Better stands were found on most plots where no companion crop was used since the legumes in the oats were subjected to both the competition of the oats and a direct spray contact.

Control of lambquarters (Chenopodium album) and ragweed (Ambrosia artemisiifolia) was satisfactory with 2,4-D and MCP at both 1/4 and 1/2 pounds per acre. 3,4-D was considerably less effective at comparable rates. Initial injury from 3,4-D occurred as epinasty and stem proliferation but in many cases regrowth occurred from development of lateral buds following death of the terminal bud.

(b) Control of Downy Bromegrass (Bromus tectorum) in Alfalfa Stands:

Dalapon, sodium TCA and Cl-IPC were applied April 6, 1954 on an established stand of alfalfa heavily infested with downy bromegrass. Alfalfa shoots were about one inch tall and the bromegrass was still in the rosette form at the time of spraying.

Nearly complete bromegrass control without injury to alfalfa was obtained from 3, 6 or 12 pounds acid equivalent of Dalapon per acre. Good control was obtained with Cl-IPC at the 6-pound rate. Sodium TCA gave marked control of the downy bromegrass only at the highest rate used, 24 pounds acid equivalent.

(c) Chemical Control of Perennial Grasses in Legume Stands: Perennial grasses frequently become predominate in legume stands. A chemical method for regulating the grass stand without causing damage to the legume component would be desirable.

On April 16, 1954, five herbicides were applied on an established stand of alfalfa, alfalfa-timothy, Ladino clover and Ladino clover-orchardgrass. Stand estimates made on July 1 and August 26, 1954 indicated that good grass kill without injury to Ladino clover or alfalfa was obtained from 10 and 20 pounds of Cl-IPC per acre. While Dalapon was effective in killing timothy and orchardgrass at 20 pounds per acre, it was also quite injurious to Ladino clover. A 10-pound rate of Dalapon caused severe damage to Ladino clover and timothy but relatively little damage to orchardgrass. Phenyl dimethyl urea and amizol tended to kill the legumes but not the grasses.

## MAINE

Title: BREEDING AND EVALUATION OF FORAGE CROPS

Leader: L. H. Taylor

The forage nurseries and trials at Orono and Presque Isle came through the winter of 1953-54 with very little winterkilling. Adequate snow cover at both locations was probably a factor in this, as winter temperatures were near normal. The 1954 growing season was cool and extremely wet, favorable for plant diseases and not especially favorable for forage production.



Two hay cuts were made of the red clover trials at Presque Isle in 1954. In the trial of the NE-10 material there was no significant difference in total seasonal yield among the strains. The average yield was 2.62 tons of dry matter per acre. In the yield test of 30 red clover varieties, the only variety significantly different from the average of the test was Nolin which flowered early, probably in response to the long photoperiod, and had a very low yield. The average yield in this test was 2.98 tons of dry matter per acre. Both trials will be observed for survival next year and plant selections made if differences are present. A small red clover variety trial was seeded in the early summer of 1954 and a good stand secured.

The most serious diseases of red clover at Presque Isle in 1954 were root rots and northern anthracnose. Stemphylium leaf spot and Pseudo-peiziza leaf spot were also present. These diseases, and rust and sooty blotch as well, were observed on red clover in various parts of the state during the growing season.

Title: CUTTING MANAGEMENT OF LADINO CLOVER

Leader: C. S. Brown

The study begun in 1953 (1953 Annual Report, page 26) was continued in 1954. The effect of spring cutting date on percentage Ladino clover in the August aftermath was less pronounced than in 1953. Unusually cool, wet weather continued throughout the spring and summer, resulting in a two-week delay in maturation of the grasses. Results for the two seasons appear in Table 2.

Table 2--Aftermath recovery of Ladino clover following removal of the first cutting on June 1, June 22, or July 15.

Crop	Mean Percent Ladino Clover on August 15					
	1953			1954		
	June 1	June 22	July 15	June 1	June 22	July 15
	%	%	%	%	%	%
Ladino-timothy	72	64	22	55	45	29
Ladino-bromegrass	74	59	25	48	41	34
Ladino-orchardgrass	50	25	22	60	52	39

Title: FORAGE PRODUCTION OF NITROGEN-FERTILIZED GRASSES AND LEGUME-GRASS MIXTURES

Leader: C. S. Brown

Stands of timothy, brome grass, and orchard grass grown alone or in mixture with Ladino clover or Viking birdsfoot trefoil were established in 1954. Beginning in 1955, dry matter and crude protein yields will be determined for the mixtures, and for the pure stands of grasses fertilized with different levels of nitrogen. Good establishment was obtained on all plots in 1954, excepting the orchard grass-birdsfoot trefoil. Following the first clipping in midsummer, orchard grass became excessively competitive to the trefoil plants, and very poor trefoil stands remained by fall.

Title: GRASS SILAGE PRESERVATION

Leaders: H. C. Dickey, B. E. Plummer, and C. G. M. Edgerly

In 1953 grass silage was placed in three large upright silos, each containing approximately 200 tons. No wilting was practiced. One also was treated with 5.0 pounds of Kylage per ton of silage; the second received 8.2 pounds of sodium metabisulfite; and the third was left untreated.

The most important differences in the composition of the three silages at the time of feeding were their protein and carotene contents. The untreated silage was lowest in crude protein. The bisulfite silage contained more than twice as much carotene as either the Kylage-treated silage or the untreated silage. This difference in carotene resulted in increased yellow color in the milk produced by cows on the bisulfite silage. Palatability of the bisulfite silage was especially good, with some cows consuming more than 85 pounds of silage per head daily.

As shown in Table 3, total dry matter loss was much higher with the Kylage treatment. Bisulfite gave somewhat better dry matter preservation than in the untreated silage, as a result of a difference in top spoilage. This advantage for the bisulfite treatment resulted even though the tops of all three silos were tramped, covered with tar paper, and then covered with 8 inches of wet sawdust. Protein losses were similar in the treated silages and much lower than in the untreated. Carotene losses were high in both the Kylage and untreated silages, in contrast to excellent preservation in the bisulfite silage.



Table 3--Losses during storage of treated and untreated silage.

Constituent Lost	Silage Treatment	Manner of Loss		Total %
		Seepage and Fermentation %	Top Spoilage %	
Dry matter	Bisulfite	12.4	0.34	12.7
"	Kylage	28.4	0.93	29.3
"	Untreated	11.0	3.91	14.9
Protein	Bisulfite	19.7	0.46	20.2
"	Kylage	16.4	0.95	17.4
"	Untreated	32.8	4.45	37.2
Carotene	Bisulfite	-7.5	0.98	-6.5
"	Kylage	57.5	0.12	57.6
"	Untreated	60.0	0.36	60.4

MARYLAND

Title: ORCHARDGRASS BREEDING

Leader: T. S. Ronningen

The 1952 polycross progeny test (1953 Annual Report, page 27) was continued. Yields were determined from three cuttings made during the year. Notes were taken on aftermath recovery, incidence of rust and other foliar diseases and maturity characteristics. Progenies of several clones in each maturity classification maintained general superiority over the checks.

The 1953 source nursery was continued, and notes on important characters were taken.

Several restricted tests of orchardgrass varieties and advanced synthetics have been continued or established.

Title: IMPROVEMENT OF RED CLOVER ADAPTED TO MARYLAND

Leader: A. Morris Decker, Jr.

Nine promising clones were selected from material planted in 1952 (1952 Annual Report, page 35). These clones were transplanted into the field in the spring of 1954 in hopes of obtaining polycross seed in sufficient quantities to be used in further testing. However, because of unfavorable weather conditions no seed was obtained. These clones are now in the greenhouse where seed should be obtained for spring plantings in 1955.

Further screening work with southern anthracnose (Colletotricum trifolii) was continued as described in previous reports (1952 Annual Report, page 35 and 1953 Annual Report, page 27). Seed was collected from selected lines which will be used for further testing. Desirable combinations will then be used to make up new varieties.

Title: DEVELOPMENT AND MAINTENANCE OF SUPERIOR LADINO CLOVER BREEDING MATERIALS

Leader: T. S. Ronningen

Five of the 22 replicated clones (1953 Annual Report, page 27) were saved for progeny evaluation.

The 1953 evaluation nursery of 98 replicated clones (1953 Annual Report, page 28) was continued, and notes were taken on vigor, spread, disease incidence, flowering and coarseness.

Approximately 95 entries including several varieties and strains and mostly western commercial seed sources were established in duplicate in observational plots in the late summer of 1954. The purposes of this planting were to evaluate the nature and extent of variation between the lots and to provide material for selection in the breeding program.

Almost all of the 120 clones sent out for uniform testing to several states from the Pasture Laboratory were established in triplicate in 1954 with two clonal propagules per replicate.

Several hundred vegetative selections from old Maryland pastures were established as spaced plants and are being evaluated.



Title: VARIETY AND STRAIN TESTING OF FORAGE LEGUMES AND GRASSES

Leaders: T. S. Ronningen and A. Morris Decker, Jr.

Alfalfa: Williamsburg and Narragansett continue to be the most productive over three harvest years or longer. DuPuits and other French derivatives have been superior in first-year yields. In addition to several variety tests established throughout Maryland a planting of the Eastern Regional Uniform Variety Test with 15 entries in six replicates was made in 1953 and harvested in 1954.

Ladino Clover: The 1952 strain and variety test (1953 Annual Report, page 28) was not harvested in 1954. The Ladino clover was almost completely eliminated over the winter of 1953-54 from all association plots containing orchardgrass, and the severe damage in plots seeded to Ladino clover alone resulted in considerable weed encroachment. After one harvest-year in another trial one commercial lot and Pilgrim were superior to most other strains which included the Western Composite strain.

Red Clover: Stevens, a local farmer strain, has continued to be outstanding in all variety trials throughout eastern and central Maryland. The performance of Kenland and Pennscott varieties was good in central Maryland. However, Pennscott was decidedly superior to Kenland in the Eastern Shore tests, being only slightly inferior to the Stevens Reinholdt strains. Additional local farmer strains are being tested but as yet none have looked too promising.

Orchardgrass and Tall Fescue: Variety tests have been set up to compare the two species as well as varieties and strains within the species because of the similarity of use of these grasses for semi-permanent pastures in Maryland. In the first harvest-year Kentucky 31 and Alta tall fescue exceeded yields of the orchardgrass entries but not significantly so. Pasture Lab. Syn. 4 and Potomac exceeded Commercial orchardgrass in the trial on the Eastern Shore of Maryland.

Sudangrass and Pearl Millet: Three varieties of pearl millet and four of sudangrass were compared under a pasture management in three locations in the state in 1954. Hybrid #1 pearl millet developed at the Coastal Plain Agricultural Experiment Station at Tifton, Georgia exceeded all other entries in yield, most of them significantly. In addition, this entry showed very little disease injury, considerable aftermath vigor and good leafiness. Commercial pearl millet produced high yields, but headed out more profusely, was less leafy and showed poor recovery in the second and third aftermath. Starr pearl millet was similar in yield to Piper and Tift sudangrass. Sweet and commercial sudangrass were inferior in yield and resistance to foliar diseases. Piper was slightly inferior to Tift in incidence of leaf and culm diseases.

The advantage in production and aftermath vigor of superior strains of pearl millet over the better varieties of sudangrass was most pronounced on sandy soils and in the Coastal Plain area of the state.

Bermudagrass: Preliminary observational trials were begun in 1953 with Bermudagrass strains. Indications are that both Coastal and Midland will do well in the southern areas of the State. Midland is more winter hardy and starts growth a week to ten days earlier in the spring than Coastal Bermudagrass. These two strains were sprigged into half acre paddocks for observational grazing trials on May 19, 1954. In spite of extremely low rainfall during most of the summer, September yields were 0.9 and 0.5 tons of hay (12% moisture) for Coastal and Midland respectively.

Title: EVALUATION OF GRASS SPECIES AND STRAINS FOR USE WITH ALFALFA  
FOR HAY

Leaders: T. S. Ronningen and S. C. Ghose

The test at College Park (1953 Annual Report, page 29) was continued during the second harvest-year. Yields of the grass-alfalfa combinations were substantial, and most exceeded alfalfa alone except for the combination of timothy and alfalfa. In general, the most vigorous grasses with alfalfa produced the highest yields. However, later maturing strains of orchardgrass with alfalfa were high yielding yet contained a large proportion of alfalfa. Aftermath production of these combinations was greater than for early maturing, aggressive strains or varieties of orchardgrass and tall oatgrass. Several Beltsville experimental synthetics of smooth brome grass were promising in mixtures, but Achenbach as a check, was most productive when grown alone. Incidence of foliar diseases was low on all grasses which may have been due, at least in part, to a relatively dry season.

Among the grasses seeded alone, early maturing entries of tall oatgrass and orchardgrass exceeded all others in total production. Yields of the more productive grasses growing alone and fertilized with 50 pounds of N per acre after each cutting were about the same as combinations of those same grasses with alfalfa. However, distribution of yields was much more uniform for the grass-alfalfa combinations.



**Title: ALFALFA SEEDING EFFICIENCY STUDIES****Leaders: A. O. Kuhn and T. H. Schutte**

Alfalfa seedings were made at three locations in Maryland during the period of August 15 to September 1, 1953 and were evaluated during the spring and summer of 1954. These were evaluated on the basis of the number of seedlings obtained and the yield of hay.

At these locations banding the seed and/or the fertilizer had no significant effect on the stand establishment of the alfalfa or on yields obtained during the first harvest year. Comparisons were between banding of the seed and broadcasting the seed and banding of the fertilizer vs broadcasting the fertilizer, with all combinations. At all three locations no significant difference was found in the yield of the alfalfa, whether 8 or 16 pounds of seed were used on an acre basis.

**Title: TALL FESCUE MANAGEMENT****Leaders: A Morris Decker, Jr. and Uno Teemant**

A management study on Kentucky 31 fescue was continued during 1954. Treatments were the same as those reported earlier (Annual Report 1953, page 30).

Dry matter yields ranged from 1.08 to 5.91 tons per acre as compared with 1.88 to 4.25 in 1953. The greatest increase was on the fescue alone plots where 200 pounds of nitrogen were applied annually while the lowest yielding treatments were with the fescue-Ladino clover mixtures. In all cases highest yields were obtained from those plots cut for hay at a height of one inch. However, the quality of forage was not as high as on the more frequently clipped treatments. The Ladino clover-fescue association had approximately a one-third decrease in yield from last year. The clover was essentially eliminated when cut at four inches regardless of the cutting frequency. It was likewise largely eliminated from all hay plots regardless of cutting height. In the case of the alfalfa-fescue association the hay stage was again the highest yielding treatment. When cut at four inches the majority of the yield was made up of fescue while the higher yields of the one inch cut were largely alfalfa. With increased frequency of cutting the alfalfa component was greatly decreased. The reverse was true in the case of the Ladino-fescue associations where frequent clipping increased the percentage of Ladino clover. As might be expected, the Ladino clover-alfalfa-fescue association was more or less intermediate. The low clipping height tended to reduce the fescue and increase the Ladino clover especially when frequent clippings were made. Low cutting height also favored alfalfa over fescue while the fescue nearly dominated the four inch height in several instances.

Title: FERTILIZATION OF PERMANENT BLUEGRASS PASTURE

Leaders: A. Morris Decker, Jr. and Mitchell Thompson

Dry matter production was obtained for the 1954 season. Treatments used were the same as reported earlier (Annual Report 1952, page 40 and Annual Report 1953, page 31).

The range of total dry matter yield in tons per acre in 1954 was 1.10 to 3.85. The treatment of 400 pounds per acre (five applications of 80 pounds each) was badly burned by the second application and yields for the remainder of the season were reduced. The total season yield for this treatment was 3.82 while 200 pounds per acre (five applications of 40 pounds each) yielded 3.85 tons per acre.

In 1952 and 1953 the last cutting (5th) out-yielded the previous cutting for all treatments. In 1954, due to low rainfall throughout the season and exceptionally low rainfall in September, the fifth cutting was the low cutting of the season, ranging from .03 to .25 tons per acre. The average fifth cutting yield for 1952 and 1953 range was .77 to 1.19.

In the spring of 1954 a test using four nitrogen treatments was started. In this test the plots are split, one-half of the plot being cut at the same time and in the same manner as the above plots, the other half cut when the grass reached three to four inches (cut with a lawnmower equipped with a catch pan). The frequent clipping did not tend to reduce the elimination of the clover, although the dry conditions of this year probably had some adverse effect on the clover.

Title: NITROGEN FERTILIZATION ON PURE GRASS AND GRASS-LEGUME ASSOCIATIONS

Leader: A. Morris Decker, Jr.

Five forage grasses are being tested for pasture production when grown alone and in association with a legume under two levels of nitrogen (Annual Report 1953, page 31).

As would be expected, nitrogen applications on the grass alone plots greatly increased production. Yields were also substantially increased when nitrogen was applied to the grass-legume combinations which was not true with last year's results (Annual Report 1953, page 31). The reason for this increase was due to a reduction in clover stands during the 1953-54 winter period. Good clover stands were present only in the bluegrass and reed canarygrass plots. However, those clover stands were greatly reduced during the dry



summer. Grass competition was greatest with orchardgrass followed by tall fescue, tall oatgrass and Kentucky bluegrass in that order. In contrast to last year reed canarygrass stands were good and an excellent stand of clover was present in these plots in the early spring. On these same plots, contrary to what might be expected, Ladino clover stands were reduced during the summer to a greater extent where nitrogen was not applied. Favorable results were also obtained from the Kentucky bluegrass-white clover plots where nitrogen was added. Indications are that small amounts of nitrogen applied to grass-legume combinations may be desirable.

Title: GRASS AND LEGUME COMBINATIONS FOR BEEF PRODUCTION

Leaders: A. Morris Decker, Jr. and Robert L. Jones

Grazing paddocks containing Kentucky bluegrass-white clover, orchardgrass-Ladino clover, and tall fescue-Ladino clover were grazed for the fifth consecutive year during 1954. Beef gains were greatest on the Kentucky bluegrass-white clover combination with orchardgrass-Ladino clover and tall fescue-Ladino clover following in order named. Dry matter yields, as determined by the strip method, were highest from tall fescue-Ladino clover with Kentucky bluegrass-white clover and orchardgrass-Ladino clover following in that order. Regrouping of the steers was done for placement on summer pasture. Starr millet, Tift sudangrass and lespedeza were compared. Due to limited information in the literature on grazing management of lespedeza, both rotational and continuous grazing methods were used. In addition a height and frequency clipping study was initiated to lend some added insight as to the type of grazing management that would be best suited in terms of total forage production and stand persistence.

Beef gains per acre were highest from Tift sudangrass, with Starr millet and lespedeza following in order. Lespedeza production was highest in the height and frequency clipping study cut at one inch one time when compared with plots cut at two and three inches and a frequency of one, two, three, and four times.

MASSACHUSETTS

Title: FORAGE MANAGEMENT STUDIES

Leaders: Mack Drake and W. G. Colby

In 1953 the first crop of orchard- and brome grass with alfalfa and Ladino clover produced seven tons grass silage on May 21. Area A was grazed with 14 cows June 3, 4, 5, and with one cow for 20 days = 62 cow periods (4 hours per cow). Area B was given a longer recovery period and was control\* grazed with 14 cows for 11 days, June 27 through July 7 = 154 cow periods. On July 9, both areas A and B were top dressed with 100 pounds per acre of K<sub>2</sub>O as muriate of potash. By August 1, the third crop on the area B which had been control grazed was 2200 pounds dry matter as compared to 600 pounds on the area A grazed with less recovery time. It was observed in August that the alfalfa, Ladino clover, orchardgrass and brome grass plants were greatly weakened in area A with shorter recovery time. In fact weeds, bluegrass, redtop, and sedges were appearing in area A but not in area B.

What was the residual effect of better management in 1953 on forage production in 1954? Again the first cutting was harvested as grass silage on May 26. Subsequent crops were grazed after dry weight yields were determined on 1/100 acre plots. The 1954 results as lbs. of dry matter per acre were as follows:

Control grazed (B)			1953	Not control grazed (A)
1st cutting	May 26	4575		2632
2nd "	July 9	4000		3250
3rd "	Sept. 3	2062		1786
4th "	Oct. 10	----		----
			10637	7668

\*Control grazing means restricting the cows to that size area which the cows will graze completely each day. This was accomplished by moving a portable electric fence each day.

Here an increase of 2969 pounds per acre of dry forage resulted from better harvest management the preceding year. Similar differences are expected for 1955, since many of the superior forage species disappeared from the poorer managed area A in 1953.



The following yield results as lbs. dry matter per acre from varying rates of nitrogen applied May 27, on the second crop 1954 are of interest:

Nitrogen lbs./A	Controlled (B)	Not controlled (A)
30	1600	1300
60	2600	2550
90	4000	3250

This points the way to a tremendous potential in forage production through adequate fertilization and good harvest management.

Title: DEVELOPMENT OF METHODS FOR INCREASING THE AVAILABILITY OF APPLIED AND SOIL PHOSPHORUS FOR UTILIZATION BY PLANTS

Leaders: J. E. Steckel and Joseph Angelini

Phosphate fixation involves the formation of relatively insoluble phosphate compounds from the active aluminum, iron, and calcium in the soil and the applied phosphate fertilizer. Fixation will proceed rapidly from the application of soluble phosphates and more slowly from low solubility phosphates.

A material capable of combining with aluminum, iron, or calcium to form a more stable compound than the metal phosphate salts, in theory, should appreciably alter the rate of phosphate fixation. Also the same material should accelerate the solution of insoluble rock phosphate or fixed soil phosphorus. Complex formers or chelating compounds of aluminum, iron, and calcium may be expected to alter significantly the equilibrium concentration of phosphate in systems of these insoluble phosphates.

Results of solubilization experiments: Eight samples of commercial rock phosphate and one sample of colloidal phosphate rock were reacted at room temperature for 15-1/2 hours in 100 mL of 0.9 mM. disodium EDTA (pH 4.8). Sample size was adjusted to provide 0.5 millimole of phosphorus for the extraction. The solubilization of phosphorus by this treatment was found to be approximately the same for the nine samples -- 14.34 to 16.30% of the total phosphorus present. Additional extractions were performed to determine the effects of concentration of sodium salts of EDTA, citrate, and oxalate and

pH of the extracting solution on the solubilization of one of the rock phosphate samples. 0.5 millimole of phosphorus as rock phosphate in 100 ml. of 0.9 to 10.3 mM. solutions adjusted to pH 4.0, 5.0, 6.0 and 7.0 was extracted 16 hours. The percentages of phosphorus solubilized are shown in the following table:

		PERCENT PHOSPHOROUS SOLUBILIZED			
Anion and concentration		pH 4.0	pH 5.0	pH 6.0	pH 7.0
EDTA	0.9 mM	18.2	20.1	16.0	13.7
	1.7 mM	29.7	27.5	24.8	21.2
	3.4 mM	38.2	44.1	44.7	45.5
	10.3 mM	68.4	78.0	85.7	89.6
Citrate	0.9 mM	11.5	8.3	6.9	4.9
	1.7 mM	14.5	12.1	9.0	5.3
	3.4 mM	19.6	18.8	12.9	7.8
	10.3 mM	25.0	22.7	16.3	9.0
Oxalate	0.9 mM	7.6	3.1	1.3	1.0
	1.7 mM	16.9	5.2	2.5	1.6
	3.4 mM	25.4	9.1	4.2	1.9
	10.3 mM	43.3	20.4	5.9	2.4

The data show the solubilizing effect of disodium EDTA on nine samples of rock phosphate. In addition as the concentration of EDTA, citrate, and oxalate anion was increased, the percentage of phosphorus solubilized was increased as expected according to the law of chemical equilibrium. Further the effect of decreasing hydrogen ion concentration is more pronounced for citrate and oxalate anion than for EDTA anion. A similar extraction with 0.1 N sodium acetate at pH 5.5 solubilized only 2% of the phosphorus. This extraction indicates the magnitude of the single effect of hydrogen ion in solubilizing the rock phosphate. In the 10.3 mM. EDTA solution, phosphorus solubilization increases with a decrease in hydrogen ion concentration. The pK value of EDTA and calcium is 3.51 in acid solutions and 10.59 in alkaline solutions, hence the greater tendency of the chelating agent to remove calcium from the rock phosphate crystal as the solution approaches neutrality. In the case of the 0.9 mM. EDTA extractions, apparently the effect of hydrogen ion at pH 4.0 is much greater than the EDTA anion in solubilizing the phosphorus. Alkyl aryl sulfonate ("Vel") also has been found to solubilize rock phosphate in significant quantities.



Results of protection experiments: The presence of a complex former or chelating anion with superphosphate may be expected to decrease phosphate fixation as a result of the reaction between aluminum, iron, and calcium with the chelating agent. This hypothesis has been tested in a factorial greenhouse experiment using three rates of superphosphate (0, 300, and 600 pounds per acre) and three rates of oxalic acid (0, 240, and 480 pounds per acre). Wheat, which is very responsive to phosphate fertilization, was planted as the test crop on the three replicates.

The relative dry matter yield values for the three rates of superphosphate was 100, 124, and 148, and the phosphorus uptake by the crop was 100, 118, and 153. Oxalic acid alone was not effective on yield and phosphorus uptake (Yield 100, 89, 97. Phosphorus uptake 100, 90, 103).

The combination treatments of superphosphate and oxalic acid produced increases both in yield and phosphorus uptake that indicate a strong interaction effect. The 480 pound oxalic acid application with 300 pounds of super produced 12% more dry matter with 11% more phosphorus uptake from the soil than the 600 pounds superphosphate alone. The 240 pound rate of oxalic acid with 300 pounds of super produced 90% as much dry matter and phosphorus uptake from the soil as the 600 pound superphosphate treatment. These data indicate that chelating agents are effective in increasing dry matter production and phosphorus uptake. Additional experiments involving other chelating agents are in progress.

NEW HAMPSHIRE

Title: VARIETY TESTING OF ALFALFA, SMOOTH BROMEGRASS, LADINO AND RED CLOVER

Leaders: Gerald M. Dunn, Leroy J. Higgins, and Paul T. Blood

Alfalfa: Four years of yield data have been obtained on six alfalfa varieties (1952 Annual Report, page 44). Narragansett alfalfa has been highest in yield for four consecutive years. This superiority was greatest during the first and second harvest years as shown in the following table:

	Pounds Dry Weight per Acre			
	1951	1952	1953	1954
Narragansett	5563	4860	4196	4737
Variety 2nd in yield	3875	3934	3683	4647

The varieties, Atlantic and Ontario Variegated also have produced good yields. No evidence of wilt infection has been obtained.

Bromegrass: Yield data were obtained on ten bromegrass varieties at Colebrook and at Dover (1953 Annual Report, page 35). The Ladino clover in the mixture almost completely winterkilled during 1953-54. Yield differences were considerably less than for 1953. The northern varieties, significantly lower in yield during 1953, were in most cases not significantly different in yield during 1954. Highest yielding varieties in 1954 at Colebrook and Dover, respectively, were: 1) Fischer; 2) Achenbach; 3) Can. Commercial; and 1) Fischer; 2) Parkland; and 3) Lincoln. Yields for these varieties, however, were not significantly different from several other varieties in the test. The variety Lancaster was significantly lower in yield at both locations. In the test of New York synthetics, synthetic B was again highest in yield.

Ladino clover: Yield data were taken for the 4th year for seven Ladino clover strains (1951 Annual Report, page 49). Commercial Ladino clover, Certified Oregon, and FC23608 were not significantly different in yield. Stands were variable for the Ladino clover strain test seeded at Dover and Colebrook in 1953. This test will be re-seeded next spring.



Red Clover: During the winter, more N. H. Red Clover seed was obtained from one, two and three-year old isolated plants in the greenhouse. Yield forage harvests were taken from field plots seeded in July 1953 in four replications each of the following strains: New Hampshire, Dollard, Kenland, New Brunswick and Pennscott. Unfortunately, an unexpected soil difference developed in one area of the plots and the results will not be reported. The plots will be retained to observe the longevity of each strain. In July 1954, 20' x 5' plots of each of the above strains were planted in four replications on more level and uniform soil conditions for yield trials. An isolated field plot was planted for increase purposes.

Title: BREEDING OF SMOOTH BROMEGRASS AND LADINO CLOVER

Leaders: G. M. Dunn and L. J. Higgins

Bromegrass: During 1953-54, about 1500 bromegrass seedlings were inoculated with the brown leaf spot organism. These seedlings were the open-pollinated progenies of 100 bromegrass selections made at Durham. Seedlings were visually rated on a scale of 1-5, 5 being most susceptible. The average of these progenies, consisting of about 15 plants each, ranged from 1.6 to 4.1. About 35 of the most resistant plants were transplanted to the field.

A breeding nursery was established in 1954 with 40 plants each of the following strains:

13 selections made at Durham  
 5 plant introduction  
 6 Wisconsin selections  
 1 check variety (Lincoln)

These plants were established in a field in which natural infection from brown leaf spot has been relatively light. On August 11, 1954 three of the four replications were inoculated with brown leaf spot by spreading a small handful of diseased aftermath leaves on each plant. Disease ratings were taken about the end of October 1954 on a scale of 1 = most resistant, 10 = most susceptible. The average rating for each replication, consisting of about 250 plants each, was as follows:

		Rating
	Rep I	4.3
treated	Rep II	4.8
	Rep III	4.8
untreated	Rep IV	2.8

On the basis of this test, it appears that plants can be inoculated in the field for brown leaf spot when natural infection is not sufficiently high.

Further work will be done during 1955 with natural and artificial infection with the brown leaf spot organism to obtain information on the following points:

1. the reaction of clones and their open-pollinated and selfed progenies.
2. seedling vs mature plant reaction.
3. replicated clonal testing of selections.

Excellent natural brown leaf spot infection occurred in 1954 in the nurseries established during 1952 and 1953 (1953 Annual Report, page 36). A highly significant positive correlation was found in disease rating for 1952 and 1953 on 100 randomly selected plants.

Polycross seed was obtained in 1954 from 40 selections from the 1952 planting. During the winter, single crosses will be made among bromegrass selections differing in a) leafiness, estimated by separation of leaves and stems and b) among plants selected for differences in after-math production.

Ladino Clover: In Ladino clover breeding, an additional source nursery of about 1800 plants was established in 1954. This nursery was overseeded with timothy in the fall of 1954 to obtain competition and to reduce hand labor.

During 1953-54, six strains of Ladino and white clover were grown in the greenhouse to study certain morphological characteristics and to attempt to relate these to persistence. Thirty plants of each strain were grown in a greenhouse bench in replicated plots. The following results were obtained on these 6 strains:

Strain	Average Values for 30 Plants/Strain			
	Seedling root length mm., at 7 wks.	Days to stolon initiation	Stolon number at 22 wks.	Estimated stolon size* at 22 wks.
Vermont Polyploid	86	109	3.9	1.7
Oregon Certified	113	93	6.1	3.1
FC23608	122	91	5.7	3.0
Sel. #1 (intermediate type)	109	92	7.1	3.9
Sel. #2 (intermediate type)	106	86	6.6	3.8
P1198076 (Swedish White)	103	76	10.6	4.9

\*1 = large

5 = small



These plants were transplanted to the field in 1954 to try to correlate these characteristics with persistence. Similar work is being done this winter as well as a study of the following characters to correlate with persistence:

1. Rate of stolon elongation in the field and in the greenhouse.
2. Frequency of nodal root systems per unit length of stolon.
3. Rate of growth and productivity of plants differing in flowering intensity.
4. Ability of Ladino clover stolons to grow in the greenhouse when taken from the field at various periods throughout the winter.

A number of crosses will be made in the greenhouse this winter among Ladino clover plants differing in flowering intensity.

Title: THE INFLUENCE OF THE LEVEL OF AVAILABLE POTASH IN THE SOIL ON THE LONGEVITY OR PERSISTENCE OF LADINO CLOVER IN HAY STANDS

Leader: Ford S. Prince

These plots were topdressed according to schedule and two harvests were taken. In this year's harvests, increasing the potash increased the percentage of Ladino clover. Nitrogen in the fertilizer caused a considerable decrease in the percentage of clover but it increased the yield of dry matter slightly. Boron at the rate of 10 pounds an acre had little affect upon yield.

Title: THE INFLUENCE OF SOIL TYPE ON THE PERSISTENCE OF PERENNIAL LEGUMES

Leader: Allan B. Prince

In 1951 four legumes were seeded on a Stratham gravelly loam, a droughty soil in southern New Hampshire. Severe summer drought greatly restricted the yield of Ladino clover in 1953. Data for 1954, however, show a partial recovery of the Ladino clover, partly due to reseeding, and a marked decrease in the amount of red clover in the stand as compared with the previous year. The alfalfa plots continued to show the highest per cent of legume in the stand.

Percent Legume in Second Cutting\*  
1954

Red Clover	4
Ladino Clover	28
Birdsfoot Trefoil	55
Alfalfa	74

\*Based on oven-dry weights.

Title: MAXIMUM USE OF SILAGE IN FEEDING DAIRY CATTLE

Leaders: H. A. Keener and N. F. Colovos

A study was started in the spring of 1953 to determine the value of corn silage and/or hay in supplementing grass silage as a feed for dairy cattle. Twelve Holstein and twelve Guernsey cattle were started on the experiment at a few days of age and were fed 25 lbs. milk replacement, 200 lbs. dry calf starter and 300 lbs. dairy ration. No additional grain is to be fed until the animals have grown out and milked at least two lactations. Starting at a few days of age, one-fourth of the animals were given grass silage as the only roughage, another fourth received grass silage plus limited hay, another fourth received grass silage plus corn silage, and the final fourth received grass silage plus both corn silage and limited hay.

Most of the animals have now passed 18 months of age. In the case of the Guernseys no benefit has been observed from supplementing grass silage with hay. In the Holsteins supplemental hay has resulted in considerable improvement in growth. The feeding of corn silage has decreased gains in body weight with both Holsteins and Guernseys.

Title: THE EFFECT OF HEAVY FERTILIZATION OF THE SOIL ON THE MINERAL CONTENT OF FORAGE AND THE EFFECTS OF FEEDING SUCH FORAGE TO DAIRY CATTLE

Leaders: H. A. Keener, F. E. Allen, C. H. Boynton, H. A. Davis, K. S. Morrow, G. P. Percival with cooperation of K. C. Beeson, E. J. Thacker, U. S. Plant, Soil and Nutrition Laboratory, Ithaca, N. Y.

Data on the chemical composition of timothy, brome grass and Ladino clover grown on heavily fertilized soil have been accumulated for the past five years. The data indicate that such forages are frequently low in iron, cobalt, copper, manganese and magnesium. Calcium and phosphorus contents have been normal.

The nutritive value of forages grown under conditions of heavy fertilization is being studied with dairy cattle. These cattle were started on the experiment as young calves and have been fed either timothy or Ladino clover-brome grass hay and a low mineral concentrate mixture. Deficiency symptoms observed in calves were poor growth, rough coats, anemia, sagging of spinal column behind shoulders, an



ataxia of hind legs (timothy fed calves only), loss of tips of ears, and broken bones. After freshening most animals have lost weight rapidly, milk production has been low, and appetites have been poor and often depraved. All animals show various indications of nervousness. During the past two years many of the calves born to the cows on the experiment have shown varying degrees of goiter. This has not been explained on the basis of a low iodine content of the forage. During the first two years in which animals were bred, the conception rate of the timothy hay fed animals was much higher than that of those animals fed the Ladino clover-bromegrass hay. During the past year there was little difference, but this might be explained on the basis of a decrease in Ladino clover content of the Ladino clover-bromegrass mixture.

Title: THE EFFECT ON THE CAROTENE CONTENT OF GRASSES AND LEGUMES OF VARIOUS METHODS OF PRESERVATIVES

Leaders: G. P. Percival and D. Josselyn

The predominantly red clover silage that was stored in 1953 in 55 gallon oil drum silos as described in the 1953 Annual Report, page 39 was analyzed. Basing the results on the loss of the amount of carotene put in the silos, sodium meta bisulfite was a very satisfactory preservative, dried stabilized molasses was next, closely followed by the untreated material. There was considerable loss in carotene in the silage preserved with calcium formate.

A predominantly grass silage was likewise preserved early in the summer of 1954 and was analyzed late in the fall of 1954. The results again show that the meta-bisulfite was the best preservative followed by stabilized molasses with the calcium formate practically the same as the untreated. In both years all samples had a good odor and were readily acceptable by cattle with no apparent preference.

NEW JERSEY

Title: BREEDING PRODUCTIVE, WILT RESISTANT ALFALFA VARIETIES ADAPTED TO HUMID EASTERN CONDITIONS

Leaders: W. R. Battle and C. R. Skogley

Activities have been concerned with continuation of the programs for increasing wilt-resistance through a program of artificial inoculation and selection, increase and distribution of seed of the Atlantic variety, development of breeding methods, and participation in the regional and national programs for evaluation of superior new strains and varieties of alfalfa. Plantings in existence, and activities of the current season, are as follows:

1940 Atlantic Breeder Seed Field: One-half acre in area. Seed crop harvested in August, and stockpiled for future use in establishing additional foundation fields in Western States.

1951 Atlantic Breeder Seed Field: Five acres in area. Same treatment as the 1940 Breeder seed field. It is estimated that about 3 million pounds of Atlantic certified seed, tracing back to these two fields, were produced in Western States this year. Demand for certified seed of the variety still exceeds the supply, but the deficiency is rapidly being overcome.

1952 Seed Source Test: 110 seed lots of Atlantic, Buffalo and Ranger alfalfa arranged in four replications of 6 x 20 foot plots. No significant differences between generations or seed sources were found for persistence, spring growth, fall growth, recovery after harvest, maturity, insect reaction or disease reaction. Occasional lots were found to be significantly above or below the mean in yield, but no clear-cut pattern for such occurrences was noted. Up to the present, it appears that methods used in increasing seed of improved alfalfa varieties are adequate to preserve the genetic identity of the varieties.

1953 Seedling Vigor Nursery: 330 progenies of bacterial wilt-resistant selections, seeded in rows, three replications. Significant differences found for vigor, leafiness, leaf-spot reaction, date of maturity. Transplanted to wilt nursery (see below) in August.

1953 Alfalfa Quality Test: 30 alfalfa clones arranged in three replications of three plants each. Transplanted from greenhouse to field in May. Data recorded on yield, leafiness, date of maturity, protein and carotene content. Clones differing significantly for these characters will be used in studies of the practicability of breeding for high quality in alfalfa.



1953 Uniform Alfalfa Variety Test: 15 varieties, 6 replications of 6 x 20 foot plots. Data recorded on stand, date of maturity, insect reaction, yield. Atlantic and A225 were the outstanding varieties this season.

1954 Alfalfa Variety Test (North Jersey): 14 varieties, 3 replications, 10 x 20 foot plots. Seeded in April in Hunterdon County. Good establishment. No yields recorded this season.

1954 Alfalfa Variety Test (South Jersey): 15 varieties, 3 replications, 10 x 20 foot plots. Seeded in August in Gloucester County. Good establishment. No yields recorded this season.

1954 Plant Introduction Nursery: 45 foreign plant introductions, seeded in rows, two replications, for preliminary evaluation. Marked differences found in establishment, vigor, leafiness. Several introductions from Turkey appear particularly promising.

1954 Wilt Nursery: About 6000 plants representing 280 breeding lines and 11 check varieties, arranged in two replications. Each plant artificially inoculated with bacterial wilt organism. These plants represent the fourth cycle of selection for bacterial wilt resistance, and should serve as a final test of the degree of resistance which has been built up. Preliminary results indicate that the lines average more than twice the resistance of the original Atlantic materials, and many are almost completely resistant.

Title: EFFECT OF TIME OF FERTILIZING ALFALFA

Leaders: J. L. Gerwig and G. H. Ahlgren

This study was started in 1952 (1952 Annual Report, page 52) and the first year's data summarized in 1953 (1953 Annual Report, page 41). The second season's yield data showed no significant differences in time of fertilizer applications. This was in contrast to last year's data which showed a significantly higher yield when fertilizer was applied following the first cutting.

No differences in persistence or botanical composition were found due to treatments. Chemical analysis on the first year's data showed no significant difference in the removal of calcium, phosphorus or magnesium per acre due to treatments. The nitrogen removed per acre was highest in treatment following the first cutting and significantly higher than most other treatments. The potassium removed per acre was highest when the fertilizer was applied in the spring before growth started. In general the first cutting shows highest percentages of potassium and phosphorus, and third cutting showed highest percentages of nitrogen, magnesium and calcium.

Title: EFFECT OF TIME OF FERTILIZING BIRDSFOOT TREFOIL

Leaders: J. L. Gerwig and G. H. Ahlgren

This study was initiated in 1952 (1952 Annual Report, page 53) and the first year's data were summarized in 1953 (1953 Annual Report, page 44). The second season's yield data showed no significant difference in time of fertilizer application. Check treatments yielded approximately one ton less than the treated plots which was a contrast to last year's results in which there was no difference in yield between the check and treated plots.

No difference in persistence or botanical composition was found due to treatments. However, there was an increase in the birdsfoot component in all plots by approximately 20 per cent over last year's stand. In general the first cutting showed higher percentage of potassium and phosphorus and third cutting showed highest percentages of nitrogen, magnesium and calcium.

Title: EFFECT OF PLANT FOOD COMBINATION ON ALFALFA

Leaders: J. L. Gerwig and G. H. Ahlgren

This study was initiated in 1952 (1952 Annual Report, page 52) and the first year's data summarized in 1953 (1953 Annual Report, page 43). The second season yield data showed no increase in yield due to nitrogen. This was in contrast to the first year's yield data. No increase in yield was found due to phosphorus in the second year's data. An increase of approximately 1-1/2 tons due to potash was found. However, little increase was found above 200 pounds of potash.

Nitrogen and phosphorus have, as yet, had no effect on persistence or botanical composition. However, the two-year-old stand was reduced by 50 per cent when no potash was applied. Chemical analysis showed that application of nitrogen increased per cent nitrogen within the plant over all treatments except those where no potash was applied. Phosphorus application increased per cent phosphorus within the plant but not to the extent that potash did. The per cent potassium in the check plots was approximately 1 per cent whereas potash treated plots contained as much as 2 per cent. There was a significant negative correlation between potassium and magnesium within the plant.

A new study concerned with application of magnesium to high potash treated plots did not give significantly higher yields.



Title: EFFECT OF PLANT FOOD COMBINATIONS ON BIRDSFOOT TREFOIL

Leaders: J. L. Gerwig and G. H. Ahlgren

This study was started in 1952 (1952 Annual Report, page 53) and the first year's data summarized in 1953 (1953 Annual Report, page 45). The second season's yield data showed no increase in yield due to nitrogen. The first year's data showed an increase in yield due to nitrogen applications. No increase in yield was found due to phosphorus in the second year's data. An increase up to approximately 1 ton per acre was found due to heavy potash treatment.

Phosphorus and potash have, as yet, had no effect on persistence or botanical composition. However, plots with heavy nitrogen treatments have approximately 20 per cent more weeds than those plots receiving no nitrogen. Chemical analysis showed that nitrogen application increased per cent nitrogen within the plant over all other treatments. The per cent phosphorus and potassium within the plant increased as they were applied in treatments.

Title: TIME, METHOD AND STRAIN EVALUATION OF INOCULANTS WITH BIRDSFOOT TREFOIL

Leaders: M. A. Sprague and Claude Eby

All of the plots seeded in August 1953 in the inoculant study with birdsfoot trefoil (1953 Annual Report, page 54) exhibited poor establishment. There were no measurable differences between any of the plots.

Accordingly, care was taken to stake out the plots and reseed on the surface with the same treatment and same variety in April 1954. Seedling establishment was better than during the previous fall; however, there were no marked differences observable between strains of inoculant, the presence or absence of a sticker solution, scarification or variety. Plants dug from representative plots indicated that all plots which had been inoculated were adequately nodulated. All of the no-inoculated plots showed no nodulation. Growth of the seedlings was nearly the same.

Title: A STUDY OF THE MAXIMUM RESPONSE AND NUTRITIVE VALUE OF GRASSES TO NITROGEN AND POTASH TREATMENTS

Leaders: Carroll H. Ramage, C. Eby, R. E. Mather, B. R. Poulton,  
E. R. Purvis

Forages used in the experiment are orchardgrass, reed canarygrass, alfalfa-bromegrass mixture, and alfalfa-orchardgrass mixture. The grass plots were fertilized with 100 pounds per acre of potash and phosphorus pentoxide, and the nitrogen levels were 50, 100, 200, and 400 pounds per acre. The legume-grass mixtures received a basic 150 pounds of  $P_2O_5$  per acre, two levels of potash (150 and 300 pounds) and three levels of nitrogen (0, 75, and 150 pounds).

Three cuttings were obtained in 1953 from all plots. In 1954, four cuttings were made on the legume-grass mixtures, and three on the grasses.

Yield of Dry Matter - Two-Year Average				
Forage	Treatment			
	50#N	100#N	200#N	400#N
	lbs./acre	lbs./acre	lbs./acre	lbs./acre
Orchardgrass	5330	6300	7460	9025
Reed Canarygrass	5065	5955	7925	9300

Forage	Treatment					
	1500# per acre of					
	0-10-10	0-10-20	5-10-10	5-10-20	10-10-10	10-10-20
Alfalfa-orchardgrass	6360	6465	6410	6130	6600	6500
Alfalfa-bromegrass	6715	7235	7270	7530	6865	7565

Protein content of the grasses ranged from 12.49% to 19.42%, depending on the amount of nitrogen applied. Thus, while the amount of forage increased from 5196 pounds to 9163 pounds, an increase of 76% (average for both grasses), the yield of protein per acre increased from 649 pounds to 1779 pounds, an increase of 174%.

The experiment will be continued one more year. Yields, proximate analyses, plant population changes, and soil nutrient status are being determined. The feeding values will be estimated from chemical composition of the forage.



## Title: PASTURE RENOVATION STUDIES

Leaders: M. A. Sprague, R. J. Aldrich and A. H. Kates

Research activities dealing with pasture renovation were expanded during 1954 (1953 Annual Report, page 41). Six trials ranging from 1-3 acres were initiated on farms during the late summer and early fall. Their primary purpose was to study the effectiveness of several herbicides in subduing old sods; tillage requirements; seeding methods; fertilizer rates; and kinds of seeding mixtures.

The trials with chemicals in previous years have indicated that to be satisfactory an herbicide must translocate readily downward from the treated foliage into underground parts in order to prevent vegetative recovery. Accordingly, recent trials have dealt primarily with dalapon and amizol in comparison with TCA. Tests to date are incomplete and accordingly results obtained are not to be construed as recommendations.

Complete kills of bluegrass sods were obtained with 6 to 8 pounds of dalapon applied during June and July. Five pounds of active material applied in November was equally effective. Its action was not rapid but just as complete as with 25 pounds of TCA. Combinations of dalapon and amino triazol at 2 and 4 pounds respectively gave a more rapid kill than either chemical alone. Seeding 14 days after treatment permitted small grains to grow well. The kill obtained through the use of amizol was perhaps less consistent than that with dalapon. However, with rates above 4 pounds complete kill of all species was experienced. August and September seedings of brome grass, orchardgrass, birdsfoot trefoil, alfalfa and Ladino clover, made from a week to one month after treatments were applied, were not damaged by these two chemicals.

One trial in Northern New Jersey included fertilizer rates of 300, 800, 1500, and 1800 pounds of 5-10-10 fertilizer per acre. The seeding mixture following the use of dalapon for seedbed preparation was brome grass, Ladino clover, and birdsfoot trefoil. Seedling counts taken one month after seeding showed no evidence of differences in seedling establishment due to fertilizer treatment. However, the stand of seeded species was far superior on the chemically treated plots to those where only tillage was applied. One pasture in northeastern New Jersey tested very low in phosphorus content prior to treatment preparation. Plots of 3 and 6 diskings were used to compare the placement of 400 and 800 pounds per acre of 0-20-0 fertilizer at the time of seeding.

On two experimental pastures, comparisons were made of broadcast and band seedings in dead sods without tillage and with moderate tillage. A pasture renovator and a grassland drill were the implements used for band seeding. The use of these implements, with proper adjustment, appears to offer great promise for seeding in chemically treated sods. Seedings made in April came along exceptionally well and were ready to

graze in August. August and September seedings developed well and considerably better than most broadcast seedings made at that time. October small grain seedings, made with these implements 14 days after treatment with amizol at 4 pounds but receiving no disking, have grown exceptionally well. The grains were planted while the grass was still green and apparently alive. By December 1 the grains were tillered well and had reached a height of about 6 inches. The old sod was completely dead.

Seedling counts on a few areas indicated that brome grass establishment was poorer on areas band seeded, due primarily to too deep placement. Proper adjustment and calibration of these implements must be made prior to the seeding of small forage seedings.

Title: THE USE OF PLASTIC MATERIALS FOR THE PRESERVATION OF FORAGE CROPS

Leaders: M. A. Sprague and C. H. Reed

A new project was undertaken in 1954 in an attempt to utilize plastic materials for the preservation of surplus pasture production during the spring flush season. Two plastic sheet materials are being used: polyvinyl chloride and polyethylene sheet films. Initial studies with these materials have used their gas-tight characteristics to preserve a number of bags of silage ranging from 100 pounds to 30 tons. There was no spoilage upon opening any of the bags.

The versatility of plastic silos for farm use offers considerable promise of furthering better management of pasture lands by permitting a farmer to harvest excess pasturage in spring on small acreages at the time which is best for the crop rather than delaying harvests until enough acreages can be harvested to fill a large silo.

Title: PRELIMINARY STUDIES ON THE CHEMICAL DESICCATION OF ALFALFA FOR HAY

Leaders: E. K. Shaw and G. H. Ahlgren

Forage crop desiccation studies were continued during the summer of 1954. Thirty-one chemicals were screened for their desiccating ability upon alfalfa. These chemicals were applied at the rate of 25-50 pounds per acre, in solution as a spray, to standing alfalfa. Trials were repeated on three different days. Hourly observations were made on the days of treatment and an overall rating given to each chemical based upon visually observed effects. The rating scale ranged from 1-5; 1 being very satisfactory and 5 unsatisfactory.



The five chemicals attaining the highest rating in the screening trials were used for further testing. These chemicals were: (1) 2-ethylhexanoic acid, (2) chloroacetic acid, (3) ammonium 2-ethylhexanoate, (4) caproic acid, and (5) 2-ethylhexaldehyde. These chemicals were applied on three different days to 3 x 12 foot plots of standing alfalfa at the rates of 10, 25, 50, and 100 lbs. per acre. Cumulative, average results were as indicated in the following table:

Average percentage moisture reduction of uncut alfalfa treated with five chemicals at 50 pounds per acre<sup>1</sup>.

<u>Chemical</u>	<u>Moisture Loss<sup>2</sup></u>
2-ethylhexanoic acid	25.2
Ammonium 2-ethylhexanoate	23.9
Chloroacetic acid	18.2
Caproic acid	22.8
2-ethylhexaldehyde	14.2

<sup>1</sup>Samples drawn 3 hours after applying chemicals.

<sup>2</sup>Average per cent moisture of control was 72 at time of treatment.

The results of the test indicate that the chemicals cause the greatest moisture loss during the first three hours after treatment. There does not appear to be a direct correlation between the rate of treatment and the per cent moisture loss. There appeared to be a continuous increase in moisture reduction up to the 50 pound rate.

The three chemicals showing the greatest response in the above test were used for further testing. This test was in terms of the determination of the effects of the chemicals plus natural drying. Results indicated that there was little or no increase in moisture reduction attributable to chemical treatment in the presence of natural drying. However, there was a decided increase in total drying. The final test was a comparison of the effects of the chemical giving the most outstanding response in 1953 (lauryl ammonium 2-ethylhexanoate) with the chemical showing the most outstanding response in 1954 (2-ethylhexanoic acid). The results indicated that there was little difference in the drying rates of the two chemicals under the conditions of the test. This test was conducted (3 trials) during the month of October when weather conditions were adverse. However, both chemicals caused an average moisture loss of 15% to standing alfalfa in 3 hours.

It seems feasible that, with additional study and research, chemicals might be used for forage drying in the future. The greatest limitation at the present status of the study, appears to be the loss of green color due to chemical treatment. The quality as well as palatability of such forage is questionable.

Title: STUDIES FOR THE CONTROL OF HORSENETTLE AND CURLED DOCK IN PASTURE AND HAY CROPS

Leaders: R. J. Aldrich and H. E. Bradbury

Studies were begun to develop satisfactory control measures for horsenettle (Solanum carolinense) and curled dock (Rumex crispus) in pastures and hay crops. Tests initiated during 1954 were designed to screen potential herbicides. Data will not be available until 1955.

Title: THE GROWTH POTENTIALS OF GOOD GRASS LEGUME PASTURES FOR RAISING DAIRY CALVES

Leaders: Bruce R. Poulton, W. P. Apgar, C. G. Wettstein

The object of this study is to determine the value of new seedings of Ladino clover and orchardgrass pasture for growing dairy calves from 4-8 months of age; 8 groups of 3 calves were selected. The age of the calves was consistent within groups. One calf from each group was put on one of 3 rations.

Ration B: This group of calves was confined to the barn where they received their hay and grain from bunkers. A paved exercise lot was available.

Ration C: This group of calves spent the 17-week experimental period on a bluegrass pasture where they received hay and grain from bunkers.

Ration P: This group of calves was put on new stands of Ladino clover and orchardgrass. They grazed these lush pastures for 24 hours a day for the entire 17 weeks. Hay was available to this group of calves but consumption was negligible.

Grain feeding was consistent for all animals and was supplied in relation to body weight. During the first 2 weeks of the trial the heifers on the lush pastures suffered severe weight losses. After 2 weeks they had become accustomed to the grass and from this point on little difference in weight gains was shown between groups.

The calves in Group B and C consumed over 12 lbs. of hay per day per calf. Calves in Group P received over 60% of their total daily nutrient requirement from pasture.

These studies will be repeated during the summer of 1955.



Title: A STUDY DESIGNED TO MEASURE THE MILK PRODUCING POTENTIALS OF GRASS-LEGUME SILAGE

Leaders: Bruce Poulton, R. E. Mather, J. W. Bartlett

A three lactation study of the amount of milk which can be produced by cows fed grass-legume silage ad libidum as the principal roughage with hay intakes restricted to 5 lbs. of alfalfa-bromegrass hay is in progress. Grains to be fed at three levels based on the daily production of 4% fat corrected milk.

Twenty-four dairy cows representing two breeds are being used in these investigations. They are divided into three groups of eight cows each. The first group of eight cows will receive no grain, the second group receives grain at the level of one lb. for each six lbs. of 4% fat corrected milk, and the third group receives grain at the rate of 1-3.

During the first lactation the production of the no grain group was 7,965 lbs. of 4% F.C.M., the cows in the medium grain (1-6) group produced 10,346 lbs. of 4% F.C.M., and the cows in the heavy grain (1-3) group produced 13,055 lbs. of 4% F.C.M.

This study is now in its second of three years.

Title: THE "ZERO PASTURE" OR CHOPPED FORAGE PROGRAM FOR DAIRY CATTLE IN NEW JERSEY

Leaders: Bruce Poulton, Claude Eby, Frank Wright

Studies initiated during the summer of 1953 were not continued during 1954 due to management difficulties. These studies will be continued during the summer of 1955, with the use of self feeding wagons. The same forage available for pastures will be utilized as green feed.

Title: RESEARCH WITH PASTURES FOR LIGHT HORSES

Leader: H. W. Gausman

Experimental work with pastures for light horses has been limited in the United States. Pasture recommendations have usually evolved from observations and experiences of successful breeders or from research on pastures for a Kentucky bluegrass and white clover pasture.

The New Jersey Agricultural Experiment Station recommends Kentucky bluegrass and white clover for horse pasture. It recognizes, however, that this mixture has disadvantages such as the low production of nutritious forage during the summer. Research recently initiated is concerned with mixtures of other grasses and legumes which might be palatable to horses and in addition be more productive and nutritious. These mixtures are necessarily experimental, since research concerning pastures for light horses in New Jersey was not begun until 1953.

Birdsfoot trefoil appears promising as a legume for horse pasture. Hence studies are underway at New Brunswick to determine effects of different management systems on its yield and nutritive value, to study its compatibility with twenty-four different mixtures of grasses and legumes, and to investigate interactions of factors which are known to affect its establishment. Experimental mixtures with trefoil have also been established at two locations in New Jersey.

Six grasses including timothy, Kentucky bluegrass, tall fescue, brome grass, orchardgrass, and reed canarygrass have been established on three levels of soil fertility. Differences in the yields and nutritive values of the grasses will be noted. Grasses new to New Jersey are also being tested for their possible use in horse pastures.

Preliminary investigations are in progress in regard to the possible use of sudangrass for supplemental pasture. Tests include simulated pasture conditions with several varieties of Sudangrass, and a yield study with different fertilizers, and methods and rates of seeding.

#### CORNELL UNIVERSITY (NEW YORK)

Title: BREEDING AND CYTOGENETIC INVESTIGATIONS WITH THE FORAGE PLANTS OF NEW YORK

Leaders: R. P. Murphy, S. S. Atwood, C. C. Lowe, and E. W. Sprague

This report covers the fiscal year 1953-54 (1953 Annual Report, page 47). The breeding and cytogenetic studies are described here separately for each species.

#### A. Alfalfa

1949, 1950 Clonal Nurseries: The clones in these nurseries were studied again in 1953 and the most outstanding ones were propagated vegetatively and included in a new clonal and polycross seed production nursery established in 1953. These clones were also inoculated with the bacterial wilt organism. The 1949 Clonal Nursery has since been discarded.



1951, 1952 and 1953 Maintenance Nurseries: These nurseries will be continued in further years. The purpose of these nurseries is to keep several cuttings of each clone in the breeding and research program available for use when needed here or by cooperating states.

1949 Single Cross Nurseries: The plants in these nurseries were observed again in 1953 and the best ones were selected for the new 1953 clonal and polycross seed production nursery. The single cross progenies in this nursery have been studied fairly intensively since 1950. Twelve of these single crosses have been selected for use in the breeding program, either as varieties directly or as parents of double-cross varieties. Appreciable quantities of seed of the first-advanced-generation single crosses were produced in cages with honeybees again in 1953. In addition, some seed of the double crosses which were planned from the single crosses was produced in Lincoln, Nebraska, in 1953. These single crosses and double crosses will be tested extensively in New York State as seed becomes available. The original single-cross nurseries established in 1949 have been discarded.

1949 Inbred Progeny Nursery: This nursery was observed again in 1953 and the best plants selected for the 1953 clonal and polycross seed production nursery. A few relatively outstanding progenies were observed among the 1-year inbred progenies of a number of the selected clones in the breeding program. This nursery has been discarded. It served a good purpose as a source of new desirable plants and as a progeny test of the parental clones.

1950 Single Cross and Inbred Progeny Nursery: The plants in these nurseries were observed again in 1953 and a few outstanding ones were selected and included in the 1953 clonal and polycross seed production nursery. These nurseries will be continued and observed again for plants which are long-lived and which have a creeping-rooted habit of growth.

1951, 1952 and 1953 Seedling Source Nurseries: These nurseries were observed in 1953 and will be studied again. Some new populations involving creeping-rooted material are present in these nurseries. A number of progenies from crosses between perennial-diploid species of alfalfa such as Medicago sativa, Medicago falcata and Medicago gaetula are present in these nurseries. We are looking for new sources of variation and new desirable characteristics which might be incorporated into alfalfa.

1953 Clonal and Polycross Seed Production Nursery: This nursery was established last year from cuttings of individual plants which had been selected from the various space-planted nurseries mentioned above and a few other sources, such as old fields and other State breeding programs. Over 400 plants were established in the replicated nursery. All of these cuttings were inoculated with bacterial wilt in order to determine their reaction to this disease. Notes will be taken on this material and the better plants will be allowed to set polycross seed for progeny testing purposes.



Special Studies: The progenies from the special studies on bacterial wilt resistance, common leaf-spot resistance, potato leaf-hopper resistance, and beta-carotene content were observed in 1953 and the more desirable plants noted. These will be studied again in 1954. Another special study involving the fertility and cytogenetic relationships among the various perennial diploid species of alfalfa will be continued. A large number of desirable plant materials are coming out of these special studies.

#### B. Red Clover

No intensive breeding or cytogenetic studies are involved with this crop at the present time. There does not seem to be a great need for a study of this crop; fairly satisfactory varieties are available to the farmer. Perenniality would be a desirable characteristic and some effort is being continued to collect seed from 3-year old plants from old stands where possible.

#### C. Ladino Clover

No intensive breeding or cytogenetic studies are now in progress with Ladino white clover. This species is involved in the clover interspecific hybridization program.

#### D. Clover and Birdsfoot Trefoil Interspecific Hybridization

No work was done on this project during 1953 other than to maintain the materials that had been previously produced. Thus far the  $F_1$  plants produced from the cross between Trifolium ambiguum and T. hybridum have been completely sterile. This has been disappointing as it had been hoped that these plants could be intercrossed or backcrossed to one or both of the parents. The progenies from the birdsfoot trefoil crosses, which involved natural tetraploid plants crossed with plants which are presumed to be artificially doubled diploid narrow-leaf plants, are being maintained. Additional progenies of this cross will be produced and studied. Although these plants have not been grown in the field, a number of them seem to be very vigorous.

#### E. Alfalfa, Clover and Grass Introduction Nursery

These nurseries are being maintained and seed will be produced on a number of the collections of alfalfa which have persisted for a 3 or 4-year period. Seed has been harvested from a number of the grasses which were included and has been made available to others for testing purposes. A few of the collections of alfalfa and one or two collections of the brome grass may have value in our breeding program. Nothing promising has been observed in the small number of introductions of clover which have been grown.



## F. Smooth Bromegrass

The 1952 source nursery of seedling plants was studied in considerable detail in 1953. A number of outstanding plants were selected and it was interesting to note that for the most part these came from a relatively small number of parental plants which had been selected and included as parents of the experimental synthetic varieties which are now being evaluated extensively in other projects. This is essentially the second cycle of selection for this crop in New York State, and it appears that considerable progress can be made by further cycles of selections.

Title: THE EVALUATION OF FORAGE CROPS VARIETIES AND STRAINS FOR THEIR USE AND ADAPTATION IN THE NORTHEAST

Leaders: R. P. Murphy, C. C. Lowe, and S. S. Atwood

This report covers the fiscal year 1953-54 (1953 Annual Report, page 49). The progeny testing of selected plants and other research conducted under this project will be reported here separately for each species.

## A. Alfalfa

1948 Ranger Increase Study: Further data were obtained from this experiment in 1953. Results continue to indicate that the present system of certification is adequate and has maintained a high degree of varietal purity as measured by the actual performance of these various increases of Ranger alfalfa under field conditions at Ithaca.

1952 Seed Source Tests with Ranger, Buffalo and Atlantic: Tests of the large number of seed sources of each of these varieties were established in 1952 at Aurora and at Ithaca. Because of the poor establishment and encroachment of weeds at Aurora, the tests there were discarded. Relatively good stands were obtained in the tests at Ithaca, but some difficulty was encountered from volunteering Ladino and white clover. The tests were studied in detail in 1953. No differences in performance of the progenies from Buffalo and from Atlantic were noted. However, there was considerable variation among the different seed sources of Ranger which were tested, and highly significant differences in yield from one cutting were obtained. However, there was no consistent difference in performance of seed sources from different States or from different generations of increase. It seemed that some seed lots probably gave poor establishment and stands because of the fact that the seed was old and low in germination, even though efforts were made to correct for differences in rate of germination.



1948 New York Polycross Progeny Test: These progenies were observed again in 1953 and a few of the best plants were collected and included in the new clonal and polycross seed production test conducted under the Bankhead-Jones Project #76. This test has been discontinued.

1948, 1949, 1950, 1951, 1952 Uniform Advanced Nurseries: Data were taken from these nurseries again in 1953. A number of better progenies were noted and the parental clones selected for inclusion in new experimental synthetic varieties. In addition, a number of new experimental varieties were included in these nurseries and were isolated for further testing based upon the results from these preliminary tests. A number of new varieties now being tested was first observed in these tests. These include Vernal and A-225. In addition, further information on the performance of check varieties which help in making variety recommendations are obtained from these nurseries. The data from these nurseries are reported each year to the Section of Forage Crops and Diseases of the U.S.D.A., where they are duplicated and given to cooperating workers in other States. The 1948, 1949, and 1950 nurseries will be discontinued.

1950 New York Polycross Progeny Test: This trial was studied again in 1953. On the basis of the results, a number of new clones isolated at New York will be included in further tests because of the performance of their progeny in this test. This experiment will be discontinued.

1951 Alfalfa Generation Study: This experiment was studied again in 1953. The results were relatively similar to those obtained in 1952. The indications are that there is very little difference in yield between the different advanced generations of an experimental synthetic variety made up from relatively few parental plants. There may be a slight drop-off in yield and vigor from the first to the second generation but it is not certain that this happens every time, and it is doubtful if it is of any great importance.

## B. Smooth Bromegrass

1951 Polycross Progeny Test: Yield and other data were obtained from this test again in 1953. The clones which produced the best progenies will be selected and, where appropriate, incorporated into experimental synthetic varieties. This test will be discontinued in 1954.

1952 Polycross Progeny Test: This test was studied in 1953 and yields were taken on the aftermath crop. The hay crop was discarded because of heavy annual weed infestations. This test will be continued. It includes the best clones which are available from the breeding work at the Pennsylvania Station as well as in New York. These clones are the basis for one phase of the new regional forage crops project which is to be initiated in the Northeast in 1954.



Isolation Plots of Experimental Synthetics for Seed Production: Seed was harvested from three new experimental synthetics for the first time, and also from the first or second synthetic generation of some of the other experimental synthetics. This seed is used for planting tests in the regular variety yield trials which include the standard check variety.

#### C. Orchardgrass

1951 Polycross Progeny Tests: These tests were observed again in 1953 and yields were obtained on the aftermath crop. Four different maturity groups were included and several outstanding progenies noted, especially among the later maturing groups. This test will be discontinued in 1954.

Isolation Plots of Experimental Synthetics for Seed Production: Seed of the first synthetic generation of four new experimental synthetics was harvested again in 1953. In addition, seed of the second synthetic generation of two other experimental synthetics was harvested. This seed is used in the testing of these experimental varieties in the regular variety yield trial in which the standard check varieties are included. These synthetics will also be included in the new regional forage crops project which is to be initiated in 1954.

#### D. Timothy

Isolation Plots of Experimental Synthetics for Seed Production: First and second generation seed was harvested from four experimental synthetics of timothy. One of these which is considerably later in maturity than common timothy appears to have considerable promise. These experimental synthetics are being tested in the regular variety yield trials in comparison with the standard check varieties.

#### E. Reed Canarygrass

Isolation Plots of Experimental Synthetics for Seed Production: Seed was not harvested in 1953 from any of the four experimental synthetic varieties. Sufficient seed is available for initial testing, but it is not planned to make further increases at this time until the values of these experimental synthetics and of this crop itself are determined.

#### F. Tall Oatgrass

1951 Polycross Progeny Test: This experiment was studied again in 1953 and yield of two aftermath crops was obtained. This test will be discontinued in 1954.

Isolation Plots of Experimental Synthetics for Seed Production: First generation seed was harvested from three of these plots and they are being tested in the regular variety yield trials in comparison with the standard check varieties.

#### G. Maintenance Nursery

A new nursery for the maintenance of all of the selected clones of the grasses was established in 1953. All clones which are currently being progeny tested or used as parents of an experimental synthetic variety and all others which might be of some value to the breeding program now or in the future are maintained in this nursery. Some of the clones which were in the old nursery could be discarded at this time, but a number of new ones were added. This maintenance in itself is a considerable task.

Title: STRAIN TESTING AND BREEDING OF FORAGE PLANTS FOR NEW YORK STATE AND VICINITY, WITH SPECIAL EMPHASIS ON PROBLEMS OF PRODUCTION DURING PERIODS OF MIDSUMMER DROUGHT

Leaders: C. C. Lowe, R. P. Murphy, R. E. Anderson, S. S. Atwood, A. A. Johnson, W. C. Johnson, K. F. Schertz, and H. A. MacDonald (Agronomy)

This report covers the fiscal year 1953-54 (1953 Annual Report, page 52).

An extensive testing program has been conducted for eight years at sites with varied soil types in the vicinity of Ithaca and under farm conditions in eight counties of the State chosen to represent diverse environments typical of various areas of the State. For each of the commercially important forage species of the State a large number of varieties and strains has been evaluated. These have included native strains, commercial varieties and new varieties developed in breeding programs in this and other areas.

Forage crop recommendations for the State are based on this testing program. Seedsmen and extension workers have been informed of test results so that an adequate and intelligent seed program can be geared to the needs of the State.

Alfalfa: Wide testing has shown Narragansett to be the best adapted variety for all short-term stands in the State. Superior vigor, stand establishment and fair leaf-spot resistance are characteristic of this variety.

Ranger which now composes the major part of the State's alfalfa acreage has demonstrated good persistence where bacterial wilt is a problem. It may be somewhat deficient in winter-hardiness for Northern New York.



Atlantic is a high-yielding, short-term alfalfa but less widely adapted to the State than Narragansett.

Commercial Grimm and Canadian Variegated seed lots have been shown inferior to the improved varieties with known sources of seed.

Vernal, a new winter-hardy, bacterial-wilt resistant variety is being tested extensively.

DuPuits and a number of other Flemish strains of alfalfa from France have shown exceptional vigor and yield. Their winter-hardiness and persistence are being tested.

Red Clover: Pennscott has proved equal or superior to the very best native strains of red clover and should prove a dependable high-yielding variety for New York.

Kenland is better than common seed but lacks in winter-hardiness for the more northern areas in the State.

Canadian varieties, Dollard and Ottawa, have performed well in some tests.

Ladino Clover: Western Certified seed lots and Pilgrim (F.C. 23608) have given better average performance than uncertified seed lots.

Some lots of imported seed have given slightly inferior performance.

Smooth Bromegrass: "Southern-type" varieties have been consistently higher yielding and given better establishment than Canadian commercial lots. Canadian has persisted better in a few trials; further testing is proceeding for this character.

Experimental synthetics developed in New York appear outstanding in yield and aftermath production. These are being widely tested for adaptation and seed producing ability.

Timothy: Medium and late-maturing strains which have been tested are better in hay quality and equal in yield to common timothy. Climax is one of the better strains. Synthetic varieties even later in maturity are now under test.

Orchardgrass: Yields of most experimental orchardgrass varieties are no higher than for common commercial seed. Strains later in maturity than Common give promise of easier management and, therefore, greater usage of this highly productive species.

Reed Canarygrass: Ioreed appears as good or better than any other varieties or synthetics tested to date.

Tall Oatgrass: Tualatin is slightly later but equal in yield with commercial. Extreme earliness and seeding difficulties still limit use of this grass.

Sudangrass: Piper appears superior to other named varieties or commercial seed under New York conditions.

Title: STUDIES OF BIRDSFOOT TREFOIL AS A FORAGE LEGUME IN NEW YORK

Leaders: H. A. MacDonald, J. B. Smith, and J. E. Winch

All phases of this investigation previously reported were continued during 1954 (1953 Annual Report, page 60). Major emphasis was given to seeding establishment, management for hay and pasture, seed setting and production, and strain evaluation and breeding for crop improvement.

Birdsfoot trefoil was found to differ from other forage legumes in its requirement for seeding establishment, primarily due to its rather slow rate of seedling development. Hard seed proved to be of little value in strengthening stands during the first year. Strain differences in Rhizobium continue to require much additional work.

Simple mixtures of birdsfoot trefoil and an associated grass gave the best results. The addition of not more than two pounds of alfalfa or red clover to the acre increased initial yield of hay or pasture where the harvest system was such as to avoid excessive competition. Persistent perennial stands were found to be assured only where limited reseeding was permitted.

The seed production potential of birdsfoot trefoil is very great. Low seed yields are primarily due to lodging of the crop, bud drop, poor pollination, seed shattering and the ever present climatic deficiencies of the North Eastern Region for seed production. The factors controlling bud drop remain unsolved. Insects and disease play a major role throughout the life cycle of the plant, resulting in limited seed production. Progress is being made in all phases of this study.

Several promising lines of birdsfoot trefoil are under study. The primary objective of the work in plant improvement is to incorporate strong seedling vigor, disease resistance and high seed yield, in some of the superior lines under study. Several lines are being increased for regional study.



Title: THE EFFECT OF STAGE OF GROWTH UPON THE YIELD, NUTRITIONAL VALUE, AND LONGEVITY OF THE PRINCIPAL FORAGE GRASSES AND LEGUMES

Leader: H. A. MacDonald

Much of the work of this project carried out during 1954 was confined to the influence of management treatments imposed during the seeding year upon later performance.

The results to date show a marked influence of defoliation either by grazing or clipping upon root reserves and early development. Taller-growing species were materially injured by frequent clipping in the first year. This was reflected in increased winter injury and slow spring growth during the first crop year. Species having a high percentage of basal leaves or having a prostrate habit of growth were injured to a lesser degree or not at all.

Alfalfa seedlings having a high incidence of leaf diseases were benefited somewhat by clipping. This was also true of stands badly infected with leaf-hopper. Studies showed that in both cases the injured organs had a high respiration - photosynthetic ratio resulting in retarded growth of new tissue and crown development.

Data and materials from previous investigations were analyzed for publication.

Title: A STUDY OF FACTORS AFFECTING SEEDLING ESTABLISHMENT OF FORAGE PLANTS

Leader: H. A. MacDonald

The investigations under this project were considerably expanded during 1954 (1953 Annual Report, page 59). Special consideration was given to seed size, hard seed, seed placement, fertilizer placement, soil conditioners and available moisture. Much of the work under way is concerned with the forage legumes commonly used in this region including alfalfa, red clover, birdsfoot trefoil and white clover.

The results to date show seed size to be an important factor in strong germination and early seedling development. Only in alfalfa and red clover did hard seed contribute to the yield of the stand, and this at low seeding rates only. Precision seed placement in the soil resulted

in stand improvement in all cases, with or without the addition of fertilizer. On soils of high fertility, band fertilizer placement showed no benefit. On all soils of medium and low fertility, studied band fertilization below the seed gave improved results. Phosphorus was outstanding in its influence on early seedling development. Injury resulted at high rates of potassium and nitrogen.

Soil conditions, including sand, sawdust, and vermiculite gave improved seedling emergence on heavy clay soils when placed in or on the soil above the seed. The greatest factors limiting strong seedling establishment were found to be: 1. inadequate, continuous soil moisture during germination and initial development; 2. low soil fertility; 3. poor soil physical condition, and 4. excessive plant competition.

Title: DISEASES OF FORAGE CROPS. SURVEY OF FORAGE CROPS DISEASES  
IN NEW YORK

Leaders: D. A. Roberts, K. D. Fezer, R. T. Sherwood, and C. S. Ramamurthi

Commonly-occurring diseases of principal forage crops in New York during 1954 are listed in decreasing order of severity as they occurred on each crop: root rots (complex etiology), common leafspot, *Stemphylium* leafspot, Northern anthracnose, and crown rot of red clover; common leafspot, spring blackstem, and bacterial wilt of alfalfa; stolon rots, *Pseudoplea* leafspot, and *Cercospora* leafspot of white and Ladino clovers; *Stemphylium* leafspot of birdsfoot trefoil; *Heterosporium* leafspot of timothy; brownspot of brome grass; and purple leafspot and leaf streak of orchardgrass. Northern anthracnose of red clover and spring blackstem of alfalfa were less severe in 1954 than in 1953 (1953 Annual report, pages 54-55).

Physiologic specialization of the red clover rust fungus was demonstrated, and studies on clover root rots were begun.



Title: INFLUENCE OF IRRIGATION AND NITROGEN FERTILIZER UPON THE YIELD  
OF AN ALFALFA-BROMEGRASS MIXTURE

Leaders: G. Levine, W. K. Kennedy and H. E. Gray

A method for using rotary sprinklers in small plot irrigation experiments was tested and found to be very satisfactory for forage crops. In addition to natural rainfall, three levels of supplemental irrigation were applied to a uniform stand of alfalfa-bromegrass. The soil was a gravelly loam which was liberally fertilized with phosphorus and potash. Three nitrogen fertility treatments were studied under each of the four moisture levels.

Yield increases were the same for the three levels of supplemental irrigation and averaged 680 and 720 pounds of dry matter per acre during the summer months of 1953 and 1954 respectively. However, the spring production of 1954 was reduced by 550 pounds of dry matter per acre when the plots had been irrigated the previous summer. Thus irrigation showed a net yield increase of only 850 pounds of dry matter per acre over a two-year period.

Nitrogen fertilizer increased yields 760 and 1200 pounds of dry matter per acre in 1953 and 1170 and 2430 pounds of dry matter per acre in 1954 for 100 and 200 pounds of actual nitrogen per acre respectively. No irrigation x nitrogen fertilizer interaction was observed.

Title: EFFECTS OF PRESERVATIVES UPON THE DRY MATTER LOSSES AND  
FEEDING VALUE OF RED CLOVER-GRASS FORAGE ENSILED WITHOUT  
WILTING

Leaders: W. K. Kennedy, G. W. Trimberger, K. R. Allred and  
L. S. Wittwer

In 1952 and 1953 a red clover-grass mixture was harvested in mid-June and ensiled without wilting in four identical 10' x 30' tower silos. One silo was filled with untreated forage and the other three silos were filled with forage treated with 70 pounds of molasses, 100 pounds of brewers' dried grains, or 9 pounds of sodium metabisulfite per ton of forage. Total loss of dry matter; losses from juice runoff, fermentation and surface spoilage; chemical composition; and feeding value were measured for the different silages. Satisfactory silage was obtained when unwilted forage was ensiled without the use of a preservative but the dry matter losses were 5.7% for top spoilage, 7.4% for juice runoff and 15.2% for fermentation. Sodium metabisulfite and molasses did not reduce these high losses. Brewers' grains decreased juice runoff but had little influence upon the top spoilage and fermentation losses.

The feeding value of unwilted silages made with the four different treatments was high. In 1952 no significant differences in dry matter consumption, body weight changes, 4% fat corrected milk or digestibility of dry matter were observed. In 1953 bisulfite silage was inferior to the other silages in daily intake and bodyweight changes.

It was concluded that none of the preservatives decreased storage losses or improved the feeding value sufficiently over untreated silage to warrant their use for red clover-grass forage. If a farmer was experiencing difficulty in obtaining a good smelling silage, then the use of a preservative such as sodium metabisulfite would probably improve this condition. However, the farmer using bisulfite would be paying at least 50 cents per ton of forage ensiled as a premium for better smelling silage.

Title: THE USE OF FUNGICIDES TO PRESERVE MOIST HAY AND GRAIN

Leaders: W. K. Kennedy and Roy U. Schenk

In preliminary experiments (1953 Annual Report, page 58), salicylaldehyde and the haloketones prevented the growth of mold in moist hay and grain. Further studies revealed that both chemicals were effective for a prolonged storage period at the rate of 0.2% of the weight of the moist feedstuff. The haloketones inhibited mold growth on moist wheat and corn for a period of three weeks when applied at the rate of 0.07%. However, once the compound lost its effectiveness mold development was very rapid. Recently, the toxicity of the haloketones has been determined and the danger of using these materials is too great to justify further testing.

Methyl 2,3-dibromopropionate was applied to moist corn and found to be very effective at the rate of 0.2%. The toxicity of this compound will be determined before field testing is undertaken.

Work completed has been reported or has been accepted for publication in the *Agronomy Journal*.

Title: EUROPEAN CHAFER STUDIES

Leaders: W. George Evans and George G. Gyrisco

Biological studies of the adult were conducted during the flight period with emphasis on dispersal, frequency of flight and environmental stimuli affecting emergence.

The greatest distance flown in one nocturnal flight was found to be 725 yards. The median number of times the males emerged and participated in the swarming flight was five, while for the females this was four. The average length



of life of the adults was 6 days for the males and 7 days for the females. Under controlled conditions, caged adults were made to emerge between light intensities of zero to 400 foot-candles, but after several trials on the same group of adults the response ceased and the beetles remained inactive or sluggish until death. From observations of individual beetles in cages it appears that only those beetles which are near the surface of the soil during any particular day emerge that evening, so that only a proportion of the adult population is active on any night during the flight period.

The studies on the control of the chafer during 1954 included a successful project in cooperation with the U.S.D.A. on airplane applications of granular insecticides and another project with Dr. H. Tashiro on the large-scale colonization of milky disease in permanent pasture areas.

Several field experiments involving granular insecticides were carried on throughout the year and the data from these experiments have led to the following conclusions. The use of cyclone seeders and wheelbarrow seeders for the application of granular insecticides is a feasible method for controlling grubs in pastures and haylots. Granular formulations of aldrin, dieldrin, heptachlor and chlordane, applied to control the grubs, increased the yield of hay in one experiment from nine to twelve times and effectively controlled the second generation of the larvae. When samples of hay were analyzed for residues five days after the application of granular aldrin and dieldrin it was found that the amounts remaining after this short period were negligible.

#### Title: CLOVER ROOT BORER STUDIES

Leaders: H. H. Neunzig, A. A. Muka, C. S. Koehler and  
George G. Gyrisco

The following materials were used during the 1954 season to determine their effectiveness in controlling the clover root borer

Dust formulations - heptachlor, orthocide, isodrin, dieldrin, aldrin, diazinone, perthane, strobane, bayer L 13/59, lindane.  
Emulsifiable formulations - aldrin, endrin, heptachlor, lindane.  
Granular formulations - aldrin, dieldrin, lindane.

Of the dust formulations, good control of the beetle was obtained with 1.0 lb./acre of dieldrin, aldrin, and heptachlor. Diazinone, at a rate of 2.0 lb./acre, gave equally as good control.

Emulsifiable heptachlor and endrin, applied with a low pressure weed-type sprayer, at a rate of 1.0 lb./acre gave 90% control of the borer. Aldrin and lindane, as emulsifiable formulations, gave poor control of the insect.

Granular dieldrin, at 1.0 lb./acre, was slightly more effective than aldrin at 1.0 lb./acre, in reducing clover root borer populations. The use of granular lindane did not give adequate control of the borer.

Title: ALFALFA SNOUT BEETLE INVESTIGATIONS

Leaders: George G. Gyrisco, A. A. Muka and H. H. Neunzig

In an attempt to improve the yearly baiting program, two materials, heptachlor and isodrin, which have shown promise in preliminary tests as substitutes for the present toxicant sodium fluosilicate, were used in large scale baiting tests. Also certain constituents of the bait, such as flour and sugar, were not included in a number of the tests.

Heptachlor in the bait formulation, at a rate of 2 oz./acre, gave a 95% reduction in population one hour after application. Isodrin was only slightly less spectacular in its control of the adult snout beetle. The removal of either sugar or flour from the bait formulation appeared to have little effect upon its attractiveness and toxicity.

Emulsifiable formulations of heptachlor, endrin and malathion, at the rate of 1.5 lb./acre, were applied on alfalfa foliage. Heptachlor and endrin at these concentrations gave adequate control of the insect.

Plots treated with aldrin or dieldrin granules in 1953 in an area infested with alfalfa snout beetle larvae were dug and examined for larval mortality. Statistical analysis of the data obtained indicated that 5 and 10 lb./acre of either material gave significant control of the insect. Dosages as low as 2.5 lb./acre of these and other granular materials were applied this summer to similar plot layouts. These are to be examined in 1955.



## Title: STUDIES ON THE INSECTS OF BIRDSFOOT TREFOIL

Leaders: H. H. Neunzig and George G. Gyrisco

Studies during 1954 of the insects associated with birdsfoot trefoil were mainly a continuation of the project initiated last year. That is, through the use of net sweep sampling, collection of legumes, caging, and field observation, information was obtained concerning which species are present in a stand of birdsfoot trefoil, and which of these forms are injurious.

The following insects were found to damage the plant parts as indicated:

<u>Philaenus leucophthalmus</u>	- dwarfing of stems (rosetting) blighting of terminals
<u>Macrosiphum pisi</u>	- slight dwarfing of stems and leaves
<u>Empoasca fabae</u>	- chloronemia, anthocyanescence and tip burn of leaves
<u>Adelphocoris lineolatus</u>	- blasting of buds and blossoms blighting of terminals shriveling of seed
<u>Adelphocoris rapidus</u>	- same as <u>A. lineolatus</u>
<u>Lygus oblineatus</u>	- blasting of young buds shriveling of seed
<u>Euschistus variolarius</u>	- shriveling of seed
<u>Melanoplus femur-rubrum</u>	- leaves and green legumes incised or completely devoured
<u>Melanoplus bivittatus</u>	- same as <u>M. femur-rubrum</u>
<u>Acheta assimilis</u>	- brown legumes shredded and seeds removed
<u>Nemobius fasciatus fasciatus</u>	- same as <u>A. assimilis</u>
<u>Frankliniella tritici</u>	- pitting of wing petals of floret
<u>Brachypterolus pulicarius</u>	- ragged holes in unexpanded florets floral reproductive parts damaged
<u>Brachyrhinus ligustici</u>	- grooving of root surface
<u>Archips rosaceana</u>	- webbing of terminal leaves severing of growing tip
<u>Sparganothis sulfurana</u>	- same as <u>A. rosaceana</u>
<u>Tortrix pallorana</u>	- same as <u>A. rosaceana</u>
<u>Tortrix velutinana</u>	- same as <u>A. rosaceana</u>
<u>Plathypena scabra</u>	- leaves and green legumes incised or completely devoured
<u>Bruchophagus gibbus</u>	- contents of seed consumed

## PENNSYLVANIA

Title: THE GENETICS AND IMPROVEMENT OF RED CLOVER

Leaders: H. R. Fortmann and R. W. Cleveland

A yield trial including several seed lots of Pennscott red clover and breeder Kenland red clover was established at State College in 1953 and harvested for yield in the past year. The lots of Pennscott had significantly higher yields than Kenland in the 1954 season.

In a graduate research problem completed by Mr. Richard Latterell, 121 lines of red clover were inoculated with Sclerotinia trifoliorum in an effort to isolate individuals resistant to this disease organism. The lines studied were open-pollinated progenies of plants selected from a disease nursery as apparently disease resistant (1953 Annual Report, page 61). The design of the experiment was such that two out of four replications of the 121 lines were artificially inoculated. The rate of inoculation was high, and less than 1% of the plants survived the disease in the treated replications. The results of this experiment could be interpreted in two ways:

1. The degree of resistance to this disease as selected in preceding generations was not great enough for adequate protection against the high inoculation.
2. Selection for resistance to this disease was not effective in past generations.

At this time it is not possible to conclude which interpretation is correct. It is likely, however, that the future of the breeding program for Sclerotinia resistance will depend upon artificial inoculation to insure the elimination of susceptible plants each generation. Although the status of the breeding material as to resistance to Sclerotinia is open to question, it is more likely that progress has been made in selection for increased persistence of stand. In the coming year an experiment is planned by which the more persistent lines may be evaluated.

Title: THE GENETICS AND IMPROVEMENT OF ALFALFA (MEDICAGO SATIVA L.)

Leaders: H. R. Fortmann and R. W. Cleveland

Evaluation of materials in uniform nurseries, variety trials, etc. established in 1949 and subsequent years was continued. A new broadcast plot planting established in 1954 consisted of polycross progenies of six rhizomatous alfalfa clones. The yielding ability, spreading habit, and other characteristics of these progenies will be evaluated in coming years. A spaced-planting of the polycross progenies of the six rhizomatous clones as well as root-spreading alfalfas of three seed lots was also established in 1954. This planting will be used in evaluation of the clones and seed lots.



Title: THE GENETICS AND IMPROVEMENT OF BIRDSFOOT TREFOIL

Leaders: H. R. Fortmann and R. W. Cleveland

Polycross progenies of 35 clones selected out of the Empire variety and 79 clones selected from European seed stocks are being evaluated as to yielding ability, establishment, and persistence in plantings which were established in 1952 at Landisville and State College, Pennsylvania. Polycross seed from the parent clones was harvested again in the 1954 season. The better parent clones and their polycross progenies are being evaluated in separate plantings as part of the NE-21 Project, Phase III.

Title: THE GENETICS AND IMPROVEMENT OF FORAGE GRASSES

Leaders: H. R. Fortmann and R. W. Cleveland

Primary emphasis in this project is devoted to orchardgrass, brome grass, timothy, and reed canarygrass.

Orchardgrass: Evaluation of clones selected at the Pasture Laboratory has been continued in the past year. Seed was harvested in 1954 from 150 clones established in a polycross nursery at State College in 1951. There are adequate amounts of polycross seed of most of these clones. The better parent clones from this nursery and their polycross progenies are being evaluated in separate plantings as part of the NE-21 Project, Phase III.

Three orchardgrass synthetics, developed by the Pasture Laboratory, were reconstituted with a new clonal formulation, and restricted polycross nurseries of these were established in 1953. For the clonal formulation of the synthetics see the 1953 Annual Report, pages 62-63. The first seed harvest of the polycross nurseries was made in 1954, and the seed obtained was planted for increase in the fall of 1954.

A polycross seed production nursery consisting of selections from an old source and polycross nursery was established in 1953. A broadcast-plot planting of open-pollinated seed from these selections was established the same year. Mr. Ivan Samarawira initiated the evaluation of the selected clones in 1954 as his graduate research problem.

Brome grass: Evaluation of selected brome grass clones by means of their polycross progenies has been continued during the last year. Synthetic varieties formulated by New York have been evaluated as to yielding ability in 1954.

Phalaris Species: A spaced planting of  $F_2$  plants from a cross between Phalaris tuberosa and Phalaris arundinacea was made in the past year. This material was obtained from Dr. R. M. Love of the University of California for the purpose of evaluation in this region (1953 Annual Report, page 63).

A spaced planting of Harding grass (Phalaris tuberosa) from several seed sources was made in 1954. The evaluation of diverse seed sources of this species is planned for future years.

#### Title: GRAZING NEW STRAINS OF LEGUMES AND GRASSES IN MIXTURES

Leaders: J. B. Washko and P. S. Williams

The following legume-grass mixtures were grazed for the second year in 1954 on one-half acre paddocks, replicated three times: Buffalo alfalfa-S-37 orchardgrass, Empire birdsfoot trefoil-Tualatin tall oatgrass, Empire birdsfoot trefoil-S-37 orchardgrass, Empire birdsfoot trefoil-reed canarygrass, and birdsfoot trefoil-timothy-Kentucky bluegrass. The production from these mixtures in terms of dry matter for the season on an acre basis were: alfalfa-late orchardgrass, 4.74 tons; birdsfoot trefoil-timothy-Kentucky bluegrass, 3.23 tons; birdsfoot trefoil-late orchardgrass, 2.61 tons; birdsfoot trefoil-tall oatgrass, 2.51; and birdsfoot trefoil-reed canarygrass, 2.42 tons. The carrying capacity, expressed as cow days per acre per season, for these mixtures in the order previously listed was respectively 303, 298, 289, 336, and 308. The chemical analyses for expressing these results in terms of T.D.N. production per acre have not been completed in time to be reported.

#### Title: FORAGE PRODUCTION OF SMALL GRAIN AND ANNUAL WINTER GRASSES

Leader: J. B. Washko

The various species listed in Table 4 were seeded in late August 1953, the small grains at three bushels and the grasses at 25 pounds per acre. Fertilizer treatments were as follows: 400 pounds per acre of an 0-15-30 prior to seeding, two levels of nitrogen prior to seeding 40 and 80 pounds of N per acre followed by a spring application of 50 pounds of N. Nitrogen was in the form of sulphate of ammonia. Due to dry weather only one grazing was obtained in the fall. The first growth was grazed in the spring, the second growth was removed as silage. Dairy heifers were the grazing animals. The results are presented in Table 4.



Table 4--Dry matter production by various species when used for fall and spring grazing.

Species	Tons Per Acre at Various N Levels							
	Fall		Spring		Silage		Total	
	11/3/53		4/19/53		6/15/54			
	40#N	80#N	40#N	80#N	40#N	80#N	40#N	80#N
Field Bromegrass	.02	.50	.05	.13	3.46	3.83	3.53	4.46
Pennoll Wheat	.02	.73	.29	.38	3.31	3.17	3.62	4.28
Tetra Petkus Rye	.98	.98	.45	.57	2.22	2.37	3.65	3.92
Balbo Rye	.19	.26	1.05	1.41	2.49	2.22	3.73	3.89
Domestic Ryegrass	.66	.11	.05	.03	3.73	3.67	4.44	3.81
Kenbar Winter Barley	.81	.16	.15	.31	2.82	2.87	3.78	3.34
Clinton Oats	.33	.49	Winter-killed ----		----		.33	.49
LeConte Winter Oats	.12	.12	Winter-killed ----		----		.12	.12

Title: RENOVATION OF UNPRODUCTIVE PASTURES

Leaders: R. S. Leach and J. B. Washko

Herbage production was measured on renovation experiments at two locations for the second year in 1954 (1953 Annual Report, page 66). Timothy, timothy and bromegrass, and timothy and Kentucky bluegrass in associations with Ladino clover, Empire birdsfoot trefoil, and Viking birdsfoot trefoil were higher yielding than bromegrass, Reed canarygrass, common orchardgrass, or S-37 orchardgrass in the same associations. The S-37 orchardgrass association was consistently lower yielding than any of the other associations included in these experiments. A high incidence of disease on the bromegrass plots was a major factor contributing to the low yields of that association during the 1954 season. Reed canarygrass in associations with Ladino clover and Empire birdsfoot trefoil gave the highest midsummer production. Ladino clover associations were high yielding on areas that received an initial fertilizer application of 500 pounds per acre of superphosphate (20%) or 300 pounds per acre of 0-20-20 in the fall than on areas which received fall applications of 500 pounds per acre of superphosphate (20%) plus 400 pounds per acre of 5-10-10 at the time of seeding. The plots which received nitrogen fertilization at the time of seeding were characterized by a lower percentage of Ladino clover in the sward. The forage yields obtained on the areas prepared by different chemical and tillage methods were similar to those obtained in 1953.

On the renovation experiments established in 1953, four grazings were made with dairy heifers in 1954. As indicated by forage samples taken before grazing, the basic mixture containing red, alsike, and Ladino clovers, timothy, and brome grass gave higher seasonal production of dry matter than a timothy-Empire birdsfoot trefoil mixture. However, the trefoil mixture was higher yielding than the clover mixture for the last three grazing periods.

Title: THE EFFECTS OF SOIL COMPACTION IN PERMANENT PASTURES

Leaders: L. T. Kardos, The Pennsylvania State University, R. R. Robinson, Pasture Research Laboratory, and R. B. Alderfer, formerly The Pennsylvania State University

The investigations on soil compaction were continued (1953 Annual Report, page 64). In the absence of heavy rains of high intensity in 1954 natural runoff losses from the compacted plots were not large, 0.57 inches as against 0.08 inches for the uncompacted plots. Most of this runoff occurred within 15 days of the time of compaction. Determination of infiltration rates during the course of the season, using a rainfall simulator, indicated a gradual improvement of permeability until in August the runoff rate from the compacted plots was less than 10% of a 1-1/2 inch per hour simulated rainfall. Upon recompaction of the plots on October 19, the runoff rate increased to 64% while the noncompacted plots remained less than 4%. By November 8 the runoff rate on the compacted plots had decreased to about 30% and on November 16 to 20%. Considerable earthworm activity was noted on the plots and it is felt that this contributed materially to improving the permeability of the compacted plots.

Forage yield differences between the compacted and noncompacted plots were not significant except at the first cutting after compaction when the compacted plots yielded less. Mechanical injury of the leaves and stems during compaction contributed materially to this reduction in yield.

Title: METHODS OF PRESERVATION AND THE MEASUREMENT OF THE NUTRITIVE VALUES OF FORAGE CROPS.

Leaders: R. L. Cowan, J. W. Bratzler, R. W. Swift, and J. B. Washko

Testing of various preservatives for grass silage (1953 Annual Report, page 69) has been continued. In July, 1953, unwilted second cutting red clover-alfalfa mixture was ensiled in small (5' diameter) wood stave silos with the following treatments (1) no preservative, (2) 7 lbs. bisulfite per ton, (3) 6.4 lbs. Kylage (calcium formate-sodium nitrate mixture), (4) no preservative, (5) 112 lbs. molasses per ton, (6) 77 lbs. dried beet pulp per ton and (7) 92 lbs. dried beet pulp + 11 lbs. bisulfite per ton. The



bisulfite treated silages were superior in color and odor to those made by the other methods. The following table shows that losses of nutrients were greatly reduced, and that in the case of the high moisture (less mature) crop with added beet pulp digestibility was significantly improved by treatment with bisulfite.

Treatment	Dry matter content	Losses			Digestion Coefficient of Silage		
		Dry matter	Protein	Energy	Dry matter	Protein	Energy
	%	%	%	%	%	%	%
1	28.4	26.7	24.8	25.8	63.9	65.8	61.9
2	28.1	3.0	6.1	2.6	63.8	62.9	61.0
3	26.2	29.6	26.3	28.7	62.4	63.7	60.5
4	31.6	21.8	22.6	22.4	59.5	58.9	56.6
5	33.2	20.2	19.9	20.7	65.7	59.3	61.7
6	19.2	31.6	39.0	30.6	65.4	63.6	63.1
7	22.6	17.2	18.0	15.3	67.5	66.3	65.4

Analyses of 50-60 samples of bisulfite-treated grass and legume silages for fermentation products show that the production of acetic and lactic acids by bacterial fermentation was limited, and inversely correlated with residual sulfite concentration in the silage. Butyric acid production was almost eliminated by bisulfite-treatment, and protein breakdown was inhibited to a satisfactory degree, despite pH values higher than normal. The evidence suggests that the forages were preserved primarily by the action of the  $\text{HSO}_3^-$  ion instead of the  $\text{H}^+$  ion.

During the 1954 season, 27 small experimental silos were filled with alfalfa. The following comparisons are included in these experiments:

1. Bisulfite treatment vs no treatment vs wilting on alfalfa harvested at 3 stages of maturity (9 silos).
2. Varying rates of application of bisulfite (0,5,8,12 and 16 lbs. per ton) to 1st crop alfalfa (5 silos).
3. Bisulfite vs Kylage vs no preservative on 2nd crop alfalfa (3 silos).
4. Ground corn cobs + bisulfite vs dried beet pulp + bisulfite vs wilting + bisulfite to reduce seepage and fermentation loss (3 silos).

These silos are now being emptied, and losses of nutrients and digestibility are being measured. Data obtained to date confirm previous reports as to effectiveness of bisulfite in reducing loss as compared to other treatments.

Title: FEEDING GRASS SILAGE TO DAIRY CALVES

Leaders: G. H. Porter and E. M. Kesler

The value of high quality grass legume silage as a source of roughage is under investigation. In the first trial 48 Holstein calves were divided into 6 groups as follows: Group I (control), starter 5 lb. maximum, alfalfa hay ad. lib.; Group II, starter 5 lb. maximum, grass silage ad. lib.; Group III, starter 5 lb. maximum, hay and grass silage ad. lib.; Groups IV, V and VI repeated the first three groups except that they were fed starter at a maximum of 2 pounds. Duration of the trial was 16 weeks. No significant growth differences were noted between treatments within a concentrate level. Calves fed silage alone or silage with hay grew as well as those fed hay. As expected, calves fed starter at the 2 lb. maximum level grew at a slower rate than did those fed at the 5 lb. level. Silage fed calves apparently were able to utilize the nutrients in silage very efficiently as indicated by equal growth on a lower dry matter intake than hay fed calves.

An additional trial is under way. Three groups of 12 Holstein calves were assigned to hay, grass silage and hay plus grass silage regimes with starter fed to a maximum of 3 pounds. In addition two groups of 5 Guernsey calves each are assigned to hay and silage feeding in order to determine whether grass silage can safely be fed to light-breed calves.

These studies tend to indicate that good quality grass silage can serve very nicely as a source of roughage for the young calf.

Title: THE EVALUATION OF GRASSES AND LEGUMES FOR HAY, SILAGE AND PASTURE

Leaders: P. H. Margolf, M. G. McCartney, J. B. Washko, R. P. Pennington and A. L. Haskins, The Pennsylvania State University. V. G. Sprague, Pasture Research Laboratory

EXPERIMENT III

Evaluation of orchardgrass, bromegrass, reed canarygrass, Kentucky bluegrass, and Ladino clover with White Holland male poults placed on range at 8 weeks of age and fed a low protein all-mash pelleted diet from 12, 14 and 16 weeks to 27 weeks of age.

Triplicate plots of good stands of orchardgrass, bromegrass, reed canarygrass, Kentucky bluegrass and Ladino clover, one species to each of the one-acre plots in each replication were used for range.

Nine hundred male poults of the Thompson strain of Broad White turkeys were reared in confinement and fed the Pennsylvania State University starter mash 27% protein until they were 8 weeks old.



Three pelleted mash mixtures of three different levels of protein were used. The mash mixtures from animal and vegetable sources were: "A" contained 20%, "B" 14% and "C" 11% protein from grains only. Adequate minerals were supplied in each of the mash mixtures.

To determine the value of the forage used and the age when the poultts were changed to the low level protein, triplicate groups of poultts were fed Ration A until they were 12-14 and 16 weeks of age respectively. From then until maturity they were fed Ration C 11% protein.

To determine the effect of feeding a higher level of protein than C, 11%, 3 additional groups which had also received ration A 20% were fed Ration B 14% at ages of 12, 14 and 16 weeks.

A continuous supply of succulent green forage was available throughout the experiment to the 45 poultts on each acre plot.

Table 5--Protein content of the herbage on range, the seasonal gain in weight of the birds and the pounds of mash fed to produce a pound of gain on ranges where 5 forage species supplied succulent feed.

	Legume	GRASSES				
	Ladino Clover	Reed Canary	Kentucky blue	Brome	Orchard	Special Pens Orchard
Protein (percent)	25.4	21.7	20.3	21.8	20.6	21.9
Gain in body weight (lbs.) 8-27 weeks 2 days	22.3	21.8	21.3	21.7	20.8	22.4
Pounds of feed used per pound of gain	3.54	3.77	3.79	3.83	3.82	3.84

Using the costs of the feed consumed for the period the turkeys were on range (8 to 27 weeks) and the actual gains in body weight for each of the plots, the feed costs to produce a pound of turkey ranged from .138 to .158 cents per pound. Ladino clover in all cases was the lowest; the highest costs per pound were in the special plots where the turkeys were fed mash mixture B 14%.

The low level protein mash ration C 11% cost approximately nine dollars per ton less than medium protein mash B 14%. Thus a considerable financial saving could be made to a grower raising several thousand turkeys on range if he fed the low level protein mash to turkeys supplied succulent greens, especially if the herbage was Ladino clover.

When the experiment was terminated, all turkeys were killed, dressed and drawn at H. B. Price's poultry processing plant, Hollidaysburg, Pennsylvania. All carcasses were graded according to the U.S.D.A. grades for turkeys, by E. J. Lawless, Jr. of the Pennsylvania Bureau of Markets, and Lester Kilpatrick of the Federal Grading Service of The Production and Marketing Administration.

Summary of grading of all carcasses:

1. 93.2% Grade A
2. 4.3% showed some staginess
3. 1.6% Grade B
4. 0.9% Grade C

## CONCLUSIONS

Under the management program of this experiment the low level protein mash (grains and minerals only) fed to tom turkeys as early as twelve weeks of age gave good growth, high quality carcasses, and a substantial saving in feed costs.

Special pens indicated that the low level protein pelleted mash mixture compared favorably with a higher level protein mash mixture fed to growing tom turkey poults on orchardgrass range where succulent green pasture was continuously available.

For the second successive year succulent green pasture was made continuously available to growing tom turkeys fed a low protein level pelleted mash mixture. Ladino clover, compared with four grasses, gave the best efficiency in pounds of feed per pound of gain.



RHODE ISLAND

Title: BREEDING IMPROVED ALFALFA FOR EASTERN UNITED STATES

Leaders: T. E. Odland and R. C. Wakefield

Two harvests were obtained on each of two alfalfa nurseries. Damage from 2 hurricanes, one in August and the other in September, eliminated the 3rd cutting. In the nursery established in 1950, Narragansett again was the highest in yield with 2.26 tons per acre. This was followed in order by Narragansett from Idaho grown seed and a new poly-cross (PC 5). Ladak with a yield of only .7 tons per acre produced the lowest yield of the 27 varieties and strains included. In the other nursery established in 1951, Narragansett was also the highest in yield with Ladak and Nevada A224 the lowest.

The breeder seed plot of Narragansett established in 1946, about 1/4 acre, was continued and 25 pounds of breeder seed harvested. The season was very unfavorable for seed production due to the excessive rainfall. A larger seed plot, established in 1949, has been discontinued. The original plot is at present producing sufficient breeder seed for the National Certified Seed Program. About one-half million pounds of certified Narragansett seed was produced in the program this year.

No further crosses were made this year but some additional data were obtained on the material in the breeding nursery.

Title: SOIL FERTILITY AND SOIL MOISTURE RELATIONS IN GRASSLAND  
OF THE NORTHEAST

Leaders: R. C. Wakefield, M. Salomon

This test was harvested for the third year (1953 Annual Report, page 74) at two locations and dry matter yields of the Ladino clover-bromeagrass mixture were determined. Successive increments of phosphate and potash were applied and gave increased yields up to certain levels depending on the residual fertility.

At the first location on the University farm, recently recovered from brush and low in fertility, response to phosphate was highly significant at 30 pounds per acre. Further increments did not increase yields. Plots not fertilized with phosphate since seeding (1951) generally yielded significantly less forage than those receiving 30 pounds.

At a second location on an area of moderate fertility, 120 pounds of phosphate per acre were needed for a significant increase over the zero level. Plots not fertilized with phosphate since seeding (1951) did not yield significantly less forage than the highest annual phosphate application.

Response to potash was studied. Various increments were applied in split application following the first cut and in the fall, application of 120 pounds per acre significantly increased yields over the 30 pound level at both locations. No further increase in yield was obtained with 240 pounds per acre.

Chemical determinations of phosphorus and potassium content of soil and forage are not completed for 1954. Results from previous years show large accumulation of potassium in the soil only at the 240 pound per acre application. The available phosphorus content in the soil was generally shown to be very small at all rates in relation to amounts applied and recovered in the forage.

#### Title: POTASH SOURCES AND RATIOS

Leaders: T. E. Odland, R. C. Wakefield, M. Salomon

Yields of a Ladino clover-bromegrass mixture were determined during the second harvest year (1953 Annual Report, page 75). Highest yields were obtained with a 320 pound per acre application of potash while lowest yields were at the 40 pound level. The ratio of potash to phosphate gave no consistent response in yield of forage. Different sources of potash did not change results.

Soil analyses revealed little accumulation of available potassium until the 320 pound rate of  $K_2O$  fertilization. No appreciable quantity of potassium was recovered from the subsoil (8-14 inches).

#### Title: SOILAGE FEEDING OF DAIRY COWS

Leaders: J. W. Cobble, B. W. Henderson, N. Rorholm

The objectives of this study are: (1) to determine effect on milk production and body weight of dairy cows when fed green chopped forage in dry lot as compared to conventional rotational pasturing practices; (2) to determine the comparative costs and return involved in such practices.



Production Phase: Two groups of 13 cows each were paired as nearly as possible according to breed, age, stage of lactation, and production of fat-corrected milk. Grain was fed at the ratio of 1 lb. to 5 lbs. of corrected milk produced, during the 112-day experimental period. The soilage group was fed field chopped forage ad lib, cut from fenced portions of the same lots as were pastured. Forages cut were combinations of Ladino clover and brome grass, timothy, orchardgrass, or bluegrass.

Analyses of data show more persistent production for the soilage group, no statistically significant changes in body weight for either group, and an increase of 571 lbs. of milk produced per acre as 14.6 acres were required to carry the dry-lot fed group; whereas, the pastured cows required 17.8 acres. Mean forage consumption in dry lot was 150 pounds of as-cut material or 22.1 lbs. on a dry matter basis.

Economic Phase: The results from one year of experimentation provide an insufficient basis from which to judge whether or not soilage feeding is economically feasible. The 1954 data show that soilage practices resulted in an increase of 571 lbs. of milk produced per acre of roughage. The income from this milk must then pay for the additional labor and machinery required.

During 1954 the labor requirements were: Chopping, 50 minutes per day, and hauling 46 minutes per day. The average distance to the field was .78 miles which, driven four times each day resulted in a daily total of 3.1 miles traveled.

Additional years' experiments will provide a sounder basis for judging soilage feeding. Indications are that it may provide a worthwhile means of expanding the size of business for farmers who already own a field chopper.

VERMONT

Title: LADINO CLOVER YIELD TRIALS

Leaders: T. R. Flanagan and A. Gershoy

Replicated plots of Pilgrim, Oregon (F.C. 23924) and polyploid Ladino clover were established in association with Alta fescue in 1953. In 1954, the first harvest year, five cuts were obtained. Supplemental irrigation was applied to maintain optimum soil moisture conditions. The plots were topdressed after each cut with a seasonal total of 360 lbs. of  $P_2O_5$  and 480# of  $K_2O$  per acre, the equivalent of a ton and a half of 0-12-16. The relatively high fertility and moisture conditions were maintained in an attempt to meet the higher requirements of the polyploid. The total yields in tons of dry matter per acre are as follows:

<u>Associations:</u>	<u>Pilgrim</u>	<u>Oregon</u>	<u>Polyploid</u>
Ladino clover	2.25	2.56	2.29
Ladino clover plus grass	3.37	3.62	3.40

These plots will be maintained for additional yield studies. Although the associated grass growth was depressed in the polyploid Ladino clover plots because of large leaf size, the stolon ground cover was comparatively thin. Additional plots are being established to determine effect of seeding rates on stolon number relative to effective ground cover.

Title: YIELD TRIALS WITH COMMERCIAL AND AUTOTETRAPLOID NARROW LEAF TREFOIL

Leaders: T. R. Flanagan and A. Gershoy

The following narrowleaf trefoil strains were established with Alta fescue in replicated plots in two locations in 1953: Commercial diploid narrowleaf, type "A" and type "B" autotetraploid narrowleaf birdsfoot trefoil, Lotus tenuis,  $4n = 24$ . Three cuts were obtained during 1954. The seasonal total yields in tons of dry matter per acre, are as follows:

<u>Associations:</u>	<u>Commercial</u>	<u>Type "A"</u>	<u>Type "B"</u>
Location 1 -			
Trefoil:	1.24	1.46	1.11
Trefoil plus grass:	3.21	3.16	2.95
Location 2 -			
Trefoil:	1.15	1.44	1.52
Trefoil plus grass:	2.47	2.60	2.78



The plots will be maintained for additional yield studies. A new series of plots is being established to also include representative hybrid progeny of crosses between the autotetraploid trefoil and European broad-leaf types.

Title: TREFOIL STRAIN TRIALS

Leader: Glen M. Wood

Three years' results with four trefoil strains grown alone and in two grass associations have been analyzed. From the table it will be seen that Mansfield and Viking have not significantly differed in mean yield from each other. Granger and Empire have each yielded about the same but have definitely shown up more poorly under average Vermont conditions than the Mansfield and Viking strains. Worthy of mention is the fact that all varieties performed better on Panton Clay at Addison than on Vergennes clay loam at Burlington. Yields at Addison averaged one-third higher than at Burlington. All varieties were cut twice each year in a stage comparable to that for silage. Granger was the earliest of all four varieties and would be in full bloom when the first cut was made whereas Empire would not have commenced blooming.

#### SUMMARY OF TREFOIL STRAIN TRIALS

1952-1954

Strain	Percent of Plot Yield			Dry Wgt. Yields In Ton Per Acre			Mean
	1952	1953	1954	1952	1953	1954	
Mansfield	56	52	52	1.10	1.44	1.50	1.35
Viking	50	56	52	.87	1.42	1.50	1.27
Granger	44	50	48	.77	1.17	1.26	1.07
Empire	41	44	45	.67	.97	1.27	.97
LSD (5%)				.16	.24	.13	.12
LSD (1%)				.21	.31	.17	.15
C.V.(%)				27.53	28.40	14.28	30.73

Title: TIME OF SEEDING AND RESPONSE OF FORAGE SEEDLINGS TO CLIMATE

Leaders: Earl Stone, K. E. Varney and Glen M. Wood

The series of plantings reported in 1953 has been continued (1953 Annual Report, pages 77-78). Harvests were taken and botanical separations made to show the effect of date of planting on yield.

Results as in previous years emphasize the desirability of early spring planting on prepared land. A stand of trefoil resulting from the hard seed in a November, 1953 planting gave a yield for 1954 very nearly equal to trefoil planted in April of 1954. Results indicate that very late fall planting may delay germination of a larger portion of seed than plantings made only a few weeks earlier. The late planting will then produce the better stand the following spring.

#### WEST VIRGINIA

Title: ALFALFA BREEDING

Leader: Dale A. Ray

The foreign introductions, persistent local selections and recommended varieties of alfalfa established in 1953 in a preliminary observation nursery were evaluated for winter recovery, disease and insect resistance, type of growth, flowering index, and forage yield. Additional foreign introductions were established in spaced plantings and collections were made from three new sources of persistent plants in old alfalfa stands in West Virginia. The introductions exhibited a wide range in recovery from the winter and in date of flowering. The two pubescent alfalfa introductions from Peru which were resistant to insect damage in 1953 again showed very slight injury in 1954. The tendency for rhizomatous type of growth was observed in introductions from Portugal and Iran. Although the variety Narragansett gave the highest green forage yield (3.74 pounds per plant), plant introductions from Portugal and Iran produced more than two and one-half pounds of green forage per plant for the season. Data on self- and cross-fertility are being analyzed. Selected materials will be isolated in a breeding nursery.



Title: ATLANTIC ALFALFA SEED SOURCE TESTS

Leader: O. J. Burger

Sixteen entries of alfalfa (thirteen are Atlantic of different origin as outlined in 1953 Annual Report, page 80) replicated four times were seeded May 1, 1952. The plots were cut for hay and the first cutting was made June 8, 1953. Three cuts were made in 1953 and again in 1954.

Yield in excess of three tons was obtained from all entries. The yields ranged from 3.20 tons up to 3.92 with an average of 3.68.

No significant differences were found to exist between varieties on the season total yield basis in either 1953 or 1954. The average of the yield for two years showed New Jersey Breeder Seed from a 12-year-old stand to be first in yield.

Title: PERFORMANCE AND ESTABLISHMENT OF STRAINS AND VARIETIES OF SMOOTH BROMEGRASS IN WEST VIRGINIA

Leaders: O. J. Burger and F. W. Glover, Jr.

Eleven varieties of smooth brome grass Bromus inermis Leyss. are being evaluated on a state-wide basis, (1953 Annual Report, page 80).

Lincoln, Achenbach, Elsberry and Southland continue to give a superior performance in yield. Manchar is a variety which seems to be a promising pasture variety. Achenbach appeared to be somewhat more resistant to Helminthosporium leaf spot than the other varieties. All varieties showed evidence of this disease.

Publication of results within the next year is planned.

Title: THE INFLUENCE OF FERTILITY AND MANAGEMENT ON SEVERAL LADINO CLOVER-GRASS MIXTURES

Leaders: O. J. Burger, C. Sperow, and D. R. Browning

Description of treatments, both fertilizer and management, can be found in 1953 Annual Report, page 79. The observations made for the 1953 report continue to hold true.

The superiority of production of reed canarygrass is strikingly evident. This was especially true in the second harvest.

Chemical analyses are being made of the grass and legume fraction of the pasture cutting. The potassium data are listed below:

Potassium in Ladino clover fraction (milliequivalents per 100 grams dry matter) - average of 4 replications - 4 cuttings, 1953.

Fertilizer	Brome- grass	Reed Canarygrass	Orchard- grass	Kentucky 31 fescue	Ladino Alone	Average
<u>lbs.</u>						
0-0-0	25.9	25.7	19.1	20.9	28.5	24.0
0-80-0	23.2	23.3	20.0	19.2	27.5	22.7
0-80-80	42.4	36.9	38.6	35.1	48.6	40.3
40-80-80	40.8	40.4	29.4	33.9	47.2	38.3
Average	33.1	31.6	26.8	27.3	37.9	31.3

Title: NITROGEN ON BLUEGRASS

Leaders: G. G. Pohlman and N. M. Baughman

Nitrogen fertilizers were applied on bluegrass sod at rates of 120, 240, and 360 pounds per acre N at two dates in 1954. The plots were harvested 12 times during the season with a lawn mower and the herbage dried and weighed. The yields for the principal treatments were as follows:

<u>Treatment</u>	<u>Lb. Per Acre</u>
None	985
120 lb. N. April 15	2224
240 lb. N. April 15	3703
360 lb. N. April 15	4239
120 lb. N. July 1	2432
240 lb. N. July 1	3074
360 lb. N. July 1	3164

Increases in yield were evident for each additional increment of nitrogen, especially at the early date of application. The July application increased growth of crabgrass in the plots. Chemical analysis for protein will be made to determine recovery of nitrogen.



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